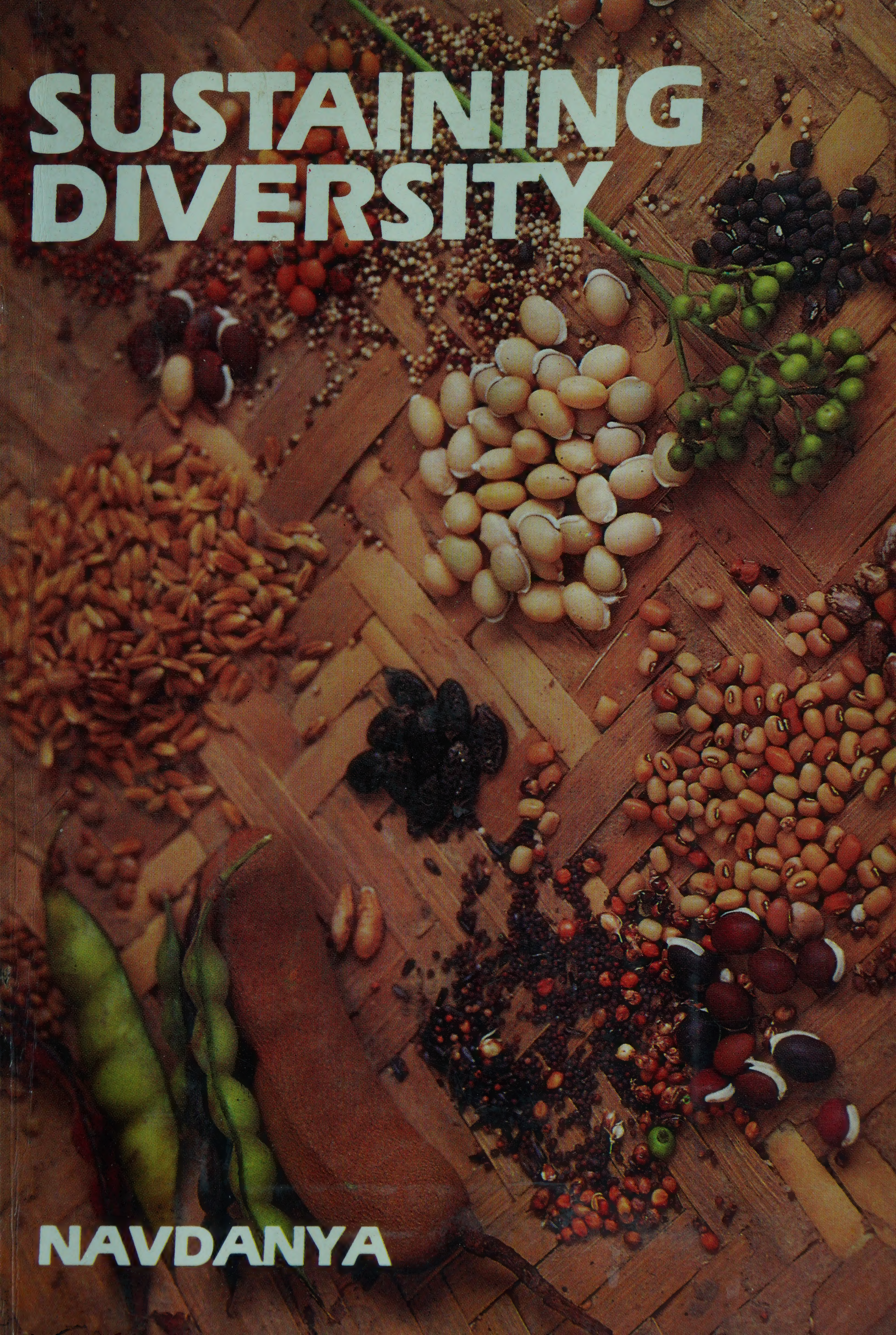
SUSTAINING DIVERSITY



NAVDANYA

SUSTAINING DIVERSITY

Renewing diversity and balance
through conservation

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NAVDANYA

ACKNOWLEDGEMENT

We, the Navdanya team wish to acknowledge the contributions of centuries of farmers who have grown and conserved diversity in their fields. In particular, we want to thank all those farmers who, through their participation in our conservation efforts, have helped us work out this source book.

We also want to acknowledge the contribution of the Plant Genetic Resource Conservation Programme of Ethiopia which has been a pioneer in developing conservation methods which build on farmers' knowledge and which serve farmers' requirements for ecologically adapted seeds that need low external inputs.

Published by the Research Foundation for Science, Technology and Natural Resource Policy

Copies available at the Foundation's office at :

A 60, Hauz Khas
New Delhi 110 016

INTRODUCTION

If we care to look around us and look in the right place, we will find black, yellow, purple, red and white beans (rajmas); we will find rice varieties that grow in dry land, in upland, in cold climate, and that have a special aroma; we will find millets that resist pest and drought. Thousands of such crops exist but are threatened by extinction. These different types were developed over the years by our ancestors to suit different ecological conditions and for different uses.

Generally speaking, genetic diversity in a crop signifies adaptation to different environments and growing conditions. The ability of a certain variety to withstand drought, grow in poor soil, resist insects or pests, or give higher protein yields is inherent in it.

For centuries, farmers have preserved valuable plants, and trees by growing them in their fields. However, with the introduction of green revolution technologies of monocultures and chemicalisation of the land, the farmers' traditional knowledge of conservation has been considered "ignorance" and led to the extinction of many plant varieties.

While acknowledging the failure of the green revolution and the loss of diversity it has caused, newer and more hazardous technologies are being introduced, which in their turn will further decrease both the existing diversity as well as the control that farmers have over such diversity.

We in Navdanya have compiled this source book on the basis of our research over 13 years on genetic erosion and actual experience over the three years in setting up community seed banks. The uniqueness of Navdanya is that it builds up on traditional farmers' exchange networks while invigorating them with new possibilities and additional knowledge derived from experiences with the formal system.

Navdanya means nine seeds. We have chosen this name because the seeds symbolise diversity. In agriculture, this is represented by the practice of sowing nine or twelve varieties at one time.

The number nine however goes beyond agriculture and signifies diversity and the cyclical nature of existence both in the cosmic as well as the earthly realm. It encompasses metaphors that belong to the large majority of our people. These metaphors are not imposed structures of language, thought, or analysis which leave rural communities incapacitated, devaluing their own knowledge and capacities, and finally resulting in the erosion of knowledge.

In the area of agricultural biodiversity and seed diversity, the cost of this destruction of farmers' knowledge is extremely high because they are the experts in the knowledge of the conservation and utilisation of that diversity. The erosion of farmers' knowledge is intimately linked to the erosion of biological diversity. The conservation of biodiversity has therefore to be based on the conservation of knowledge systems of traditional farm communities. In conserving native seed diversity Navdanya is also conserving indigenous knowledge and indigenous culture. Putting farmers, their seeds and their knowledge at the centre of conservation and cultivation decisions has been Navdanya's philosophy.

We are sharing our experiences with others interested in joining this movement to conserve native seeds and indigenous agricultural wisdom to guide the transition to sustainable agriculture. We have had many requests for help in setting up community seed banks across the country and have produced this source book to meet these needs.

Small Millet

Small millet is grown to a limited extent in India and South eastern Asia. It will yield some grain and useful fodder. It is a hardy, short duration crop and best suited to withstand both drought and water logging. The plant grows to a height of 30 - 40 cms. The grains are either white or greenish white in colour.

CONTENTS

UNDERSTANDING SEEDS

Farmers have for millennia studied, identified, modified, cultivated and exchanged seeds freely in order that they may provide for themselves the best, both nutritionally, tastewise, and for other specific purposes. In this capacity, the farmer has always been a scientific plant breeder.

Farmers have traditionally conserved and developed this diversity in their fields through on-going cultivation of the varieties.

As the farmer produced mainly for the family, the village, and then the rest of the world, with the main vision being sustainability of both lifestyle, and nature (including land and water resources), it was in his interest to conserve the plant varieties developed by him.

Diversity and Sustainable Agriculture

Genetic diversity is essential in agriculture for developing plants with characteristics to suit the ecological conditions, nutritional needs, and other uses by farmers and for conferring at least partial resistance to diseases.

Hence the concern is to understand biodiversity in its totality and not just in terms of food crops alone. There exists a symbiotic relationship in the ecological niche in which the crops grow. Diversity plays an important role in nutrient cycling, controlling insect population and plant disease. Therefore on-field conservation of all diverse plant wealth is imperative for sustainable agriculture.

Diversity and nutrient cycling

In traditional farming, with different crops planted at the same time, the land is not disturbed too much. The ground usually has a green cover over it, which promotes water and nutrient conservation. Nutrient cycling tends to be rapid. For example, in an agroforestry system, minerals lost by annuals are rapidly taken up by the perennial crop plants. In addition, the nutrient robbing tendency of some crops is balanced by the enriching addition of organic matter to the soil by other crops. Soil nitrogen fixation is improved by growing legumes along with other crops, and fungus and bacteria present in the soil, help to assimilate phosphorus better.

Diversity and insect population

Diversity in agriculture leads to diversity of abundance and increased efficiency of natural enemies of plant pests. These natural enemies depend on complexity for sources of alternate prey/hosts, habitat, pollen and nectar, shelter and over wintering sites. Plants themselves act as insect and pest repellents often. Loss of this diversity has resulted in decreased natural enemies of pests, and led to pest epidemics.

Diversity and plant diseases

In traditional agroecosystems, varieties within the same crop develop resistance to diseases. Farmers have identified these varieties and used them to develop new varieties with disease resistance. Again, farm diversity helps restrict disease outbreaks to specific parts of the farm because of multicropping.

Diversity and weed population

Traditional agriculture finds a variety of uses for a variety of plants. Thus there are very few plants which are considered weeds. In addition, practices such as crop rotation, row spacing, seeding rate, planting date, fertilisation, tillage, water management, choice of crops, multiple cropping patterns, use of weed-free crop seed, etc. are all practices which discourage the growth of weeds.

Diversity and productivity

Most cereal-legume based polyculture and agroforestry systems found throughout the tropics are highly productive where the various products of the crops are taken into account, unlike the concept of "productivity" on which the green revolution is based.

Diversity and sustainability

Traditional agrosystems are sustainable. They are well adapted to their particular environments, they rely on local resources, they are small-scale and decentralised. They tend to conserve the natural resource base.

Why has the farmer lost control over diversity, seeds and agriculture?

The two main reasons the farmer has lost control over diversity, seeds and agriculture are:

— viewing agriculture not as a sustainable lifestyle but as production for the market economy. When only the marketable product of farming - the grain, became the focus of agriculture, the paramount need was to produce more and more grain. This led to monocultures and the loss of various varieties that the farmer needed for ensuring the fertility of his soil, protection for his crops as well as for subsistence.

— the development of seeds shifted from the farmers to the scientists. With high yield as the main focus, seeds were developed to produce more grain at the cost of the other useful parts of the plant — leaves and straw. As this grain could be produced only in the presence of intensive use of chemical fertilisers, the farmer became dependent upon outside agencies — the government and the fertiliser industry — to get the chemical fertilisers and pesticides which he could not produce on his own fields. These inputs cost money, leading the farmer to depend upon subsidies and bank credits.

Marketing of the produce was also taken over by the state, and the direct link between the consumer and the producer was broken. The state purchased the produce from the producer and then passed it on to the consumer. As the remuneration for the produce was not calculated to include all costs of the farmer, the farmer was never in a position to pay off his debts and regain his independence. Farming has thus become economically not viable. Thus the farmer lost control not only over the diversity in his field, which provided his inputs, but also over what to produce and when and how and for whom to produce it.

Politics of Language

Anti-farmer bias inherent in genetic resources terminology

As long as the farmer was recognised as both the chief plant breeder and the main source of seed supply, the farming community retained ownership and therefore control over biodiversity. When the corporate sector moved in and replaced the farmer in both these areas, they introduced new phraseology to validate the distance between the farmer and biodiversity. This mindset is revealed through the use of phrases like "**landraces**", "**germplasm**", and definitions of "**variety**", "**high yield**", "**innovation**" and "**intellectual property**".

I. **Landraces**. Farmers' varieties are being called "**landraces**". This term suggests that:

- such varieties are a gift of nature, which would continue to exist and breed without human intervention.

The second implication of the use of this term is that as these varieties are gifts of nature, they cannot be owned by anyone, and become the "common heritage of mankind". The fact is that such varieties have evolved because of farmers' intervention over centuries. They cannot today exist without such continued intervention. They are actually **"farmers' varieties"**. The use of the term "farmers' varieties" recognises that the plant breeder role of the farmer, and removes such varieties from the realm of "common heritage of mankind" to the realm of varieties which needed intellectual inputs by the farmers and thus need to be protected against piracy.

While the use of the term "landraces" justifies the claims to innovation by corporations, the use of the term "farmers' varieties" makes it clear that the innovators are actually farmers and that if rewards have to be given for innovation, they need to be given to the farmers.

II. **Variety**. The word "variety" in today's agriculture does not refer any more to the vast diversity that exists today as a result of farmers' innovations over centuries. It has come to represent standardisation which needs protection by legislation like UPOV. In fact, in order to be eligible for protection under plant variety protection legislation, a variety must be:

* New — the variety must not have been exploited commercially

* Distinct — it must be clearly distinguishable from all other varieties known at the date of application for protection

* Uniform — all plants of the variety must be sufficiently uniform to allow it to be distinguished from other varieties taking into account the method of reproduction of the species

* Stable — it must be possible for the variety to be reproduced, unchanged.

This definition by its very nature rules out farmers' varieties and destroys biodiversity, and produces uniformity as necessity.

III. **Germplasm**. This term is used to denote the genetic material within the plant, particularly in the seed. Such seeds are also derogatorily called "primitive seeds".

The term "germplasm" is both scientifically inaccurate and reinforces the negation of farmers' rights by devaluing farmers' varieties. It was created by Weismann who used it to refer to hereditary component of organisms which he assumed to be totally separate from the body of the organism as well as from the environment.

The assumption of genetic material as "germplasm", as insulated totally from the organism and the environment has been proved scientifically to be false. Genetic traits and genes are not independent entities but dependent parts of the whole organism that gives them effect, plants in this case. An organism in turn interacts with and evolves in an environment which influences it. This influence is in fact, the source of biological diversity.

The term "germplasm" continues to be used today in order to further distance the farmer from the source of genetic material — seeds of diverse varieties. It assumes that while the seed is itself worthless to the farmer because it is not "improved" or "high yield", it contains "germplasm" or rather genetic material that scientists and corporations can use to improve plant varieties for the benefit of the farmer. Thus conservation of this "germplasm" becomes the concern of international and national gene banks, rather than of the farmer, who for centuries has been conserving this diversity in the farm itself.

Besides negating the plant breeding role of the farmer, such distancing of the farmer from variety turns him into a consumer for seeds produced by others (especially corporations) as the only varieties that become available to him are developed by the corporations, and mostly are seeds of plants which cannot reproduce themselves.

IV. Productivity and High Yield. The central myth that has led to the displacement of diverse farmers varieties by green revolution varieties is that the former are low yielding and the latter are high yielding and have high productivity.

Productivity is basically a ratio between output and input. Farming systems have diverse output both in terms of diverse crops as well in terms of diverse biomass of the same crop. When the total biomass is taken into account traditional farming systems based on indigenous varieties are not found to be low yielding . In fact many native varieties have higher yields both in terms of grain output as well as in terms of total biomass output (grain + straw) than the green revolution varieties that have been introduced in their place. A sample of comparative yield data from Navdanya rice collections is given to illustrate the point. (Table 1) .

The myth of high productivity of the green revolution varieties is also not borne out when all inputs are taken into account . Productivity in

traditional farming practices has always been high if it is remembered that very little external inputs are required. While the green revolution has been projected as having increased productivity in the absolute sense , when resource utilisation is taken into account, it has been found to be counter productive (Table 2).It has been found the productivity changes with shift in emphasis from land to water, from grain to total biomass production (for fodder, straw, fuel, etc.), from weight / acre to nutrition / acre. This is true in respect of industrial inputs like fertilisers.

In terms of efficiency too, the green revolution technology has proved to be far more inefficient than the technologies it displaced.Whereas in the pre-green revolution era , the energy output in terms of food was ten times the input , with the introduction of the green revolution , this output has been halved for the same input. With industrial agriculture, it is just equal to the energy input. Again in terms of finances productivity has declined with respect to the increasing cost of external inputs like fertilisers and pesticides.

In terms of nutrition , the crops displaced by the green revolution technologies include many crops which are better nutritionally than the wheat or rice they gave way to (1).

Pearl Millet

Pearl millet is an important millet in India. It has been cultivated in India and Africa since prehistoric times. The plant grows up to a height of 1.5 - 1.8 m tall. The grains are gray, rarely yellow in colour. Pearl millet is dehusked before consumption. It is usually broken into rice and cooked or ground into flour.

[1] See Biodiversity Conservation for Sustainable Consumption, Cultivating Diversity, Navdanya, 1993, pp. 16-122 for examples of nutritive values of crops replaced by green revolution cereals.

Table 1

Comparison of Yield in Green Revolution Paddy varieties and indigenous varieties in Garhwal Himalaya

Rice variety	Yield 1992			Yield 1993		
	Grain	Straw	Total	Grain	Straw	Total
Indigenous varieties						
Thapachini	66	94	160	66	92	158
Hansraj	50	80	130	48	75	123
Rikhva	56	64	12	50	66	116
Jhumkia	72	104	176	66	90	156
Rekhalya	48	80	128	48	70	118
Ghiyasu	48	80	128	58	90	168
Basmati	50	80	130	42	75	117
Ramjawan	52	64	116	40	50	90
Green Revolution varieties						
Kasturi	40	56	96	40	54	94
Pant 6	52	40	92	50	40	90
Saket 4	48	36	84	68	64	132
Saket 4	-	-	48	36	84	
Dwarf (unknown)	33	36	68	48	40	88

Table 2

Comparison of productivity of native varieties and Borlaug (Green Revolution) varieties of wheat (2)

	Native variety	Borlaug variety
Yield kg/ha.	3291	4690
Water demand	5.3 cm.	16 cm.
Fertiliser demand	47.3	88.5
Productivity with respect to water use (kg/ha/cm)	620.94	293.1
Productivity with respect to fertiliser use (kg/ha/kg)	69.5	52.99

2 Shiva, V. Violence of the Green Revolution, Third World Network, 1991, p. 196

V. Intellectual Property. Protection is being granted to what are assumed to be property rights to the products of the mind. Such protection is called Intellectual Property Rights or IPRs. Intellectual Property is defined as being something "new" or "original" which is "created" by the innovator and is capable of industrial application. This is based on a highly restricted concept of innovation. By definition, it is weighted in favour of TNCs and against citizens in general, and Third World peasants and forest dwellers in particular, in recognising only monopolistic production as intellectual property.

It has failed to recognise the more informal, communal system of innovation through which Southern farmers and indigenous communities produce, select, improve and breed a diversity of crop and livestock varieties and often, over a long period of time. It immediately excludes all sectors that produce and innovate outside the industrial mode of organisation and production. Profits and capital accumulation are recognised as the only ends to which creativity is put. It immediately excludes the farmer's fields, the unorganised sector, and women's sphere of production. Social good is considered not worthy of such recognition.

The concept of an innovator monopolising the use of his innovation by excluding from, or by charging for the use of the innovation did not exist in relation to plant varieties as long as the commercial sector was not interested in plant breeding or selling seeds. For this reason, no systematic record, oral or written was kept of who innovated and who else used the innovation for improving upon it. As such knowledge is not considered property worth protecting by international legislation, it becomes open to piracy by commercial interests who often claim protection of farmers' varieties for themselves by sheer discovery of these varieties.

In addition, in the case of the corporate sector it is the return on investments in innovation that is protected. While intellectual property protection invokes the image of the solitary innovative creator, the reality is that it is the owners of capital — the company or the corporation, and not the creators of knowledge who get the patent or breeders' rights. IPRs are a reward to owners, not creators.

Farming communities need to redefine words and claim their rights to seed, both as plant breeders and seed suppliers in order to regain control over their genetic resources.

Displacement of Biodiversity by Monocultures

With agriculture increasingly being viewed as an industry, uniformity of crops through monocultures is becoming an imperative leading to a

loss of diversity. This has generated the paradoxical situation in which plant improvement using diversity as raw material has led to the destruction of the same diversity.

The erosion of this diversity in agriculture was mainly through the manipulation of seeds and plant breeding by scientists in laboratories and not on the farm, resulting in the disappearance of traditional crop varieties.

Agriculture shifted to few varieties of wheat and rice derived from a narrow genetic base. Green revolution reinforced laboratory-oriented methods of plant breeding to produce high yielding varieties, hybrid varieties, genetically engineered seeds and tissue culture.

Different Kinds of Seeds

Seeds of agricultural crops have been developed over centuries by farming communities across the world. These seeds have been freely exchanged with other communities again across the world and have led to the development of new varieties. Today, with the entry of the commercial sector in seed production and supply as well as new technologies for producing seed, seed varieties have been given a variety of names depending on who evolved it, how it was evolved, and its potential for making profits.

Farmers' varieties are those varieties which have been developed by farmers over the years to suit their ecological, nutritional, taste, medicinal, fodder, fuel, and other needs. These have sometimes been called **landraces** to distance them from the contributions that farmers have made towards their evolution through selection. They have also derogatorily been called **primitive cultivars** in contrast to **elite cultivars** as those evolved by scientists. Farmers' varieties like any other seed variety, are an embodiment of intellectual contribution. **Farmers' varieties are perennial and sustainable.** Farmers' varieties are also referred to as indigenous seeds, native seeds, organic seeds, heirloom seeds and heritage seeds, jwaari, nate, desi, etc.

High yield varieties (HYVs), or green revolution seeds are misnamed because the term implies that the seeds are high yielding in and of themselves. The distinguishing feature of these seeds, however, is that they are highly responsive to certain key inputs such as fertiliser and irrigation. They are actually, **High response varieties. Though these seeds can be saved by farmers, they are non-sustainable due to vulnerability to diseases and pests and therefore need to be replaced**

after every few years. These seeds are also called "Sarkari" or "government" seeds as they have been developed and/or distributed primarily by the public sector.

Hybrid seeds are the first generation seeds (F1) produced from crossing two genetically dissimilar parent species. The progeny of these seeds cannot economically be saved and replanted as the next generations will give much lower yields.

Hybridisation is only one of the breeding techniques. It does provide high-yielding varieties, but so do other breeding techniques. Why did hybridisation gain such predominance over other methods? Using the example of hybridisation of corn in the US, Jack Kloppenberg in **First the Seed** explains:

> "there is an even more compelling reason to examine closely the historical choice of breeding methods in corn, for the use of hybridisation galvanised radical changes in the political economy of plant breeding and seed production. There is a crucial difference between open-pollinated and hybrid corn varieties: Seed from a crop of the latter, when saved and replanted, exhibits a considerable reduction in yield. Hybridisation thus uncouples seed as "seed" from seed as "grain" and thereby facilitates the transformation of seed from a use-value to an exchange value. The farmer choosing hybrid varieties must purchase a fresh supply of seed each year." [3a]

Hybridisation is thus like biologically patenting the seed. No one else, neither the farmer nor a rival company, can produce exactly similar seeds unless they know the parent lines, which are the company's secrets. This characteristic of the hybrid seed has been fundamental to the rapid growth of the American seed industry. The corporate seed sector in India is also involved mainly in the development of hybrid seeds including seeds of maize, sorghum, vegetables, and foodgrains. Hybrid seeds are generally called **sarkar beej**.

The New Biotechnologies

The new biotechnologies include tissue or cell culture, cloning and fermentation methods, cell fusion, embryo transfer, and recombinant DNA technology (genetic engineering).

3a, 3b Kloppenberg, First the seed p.93, p.100

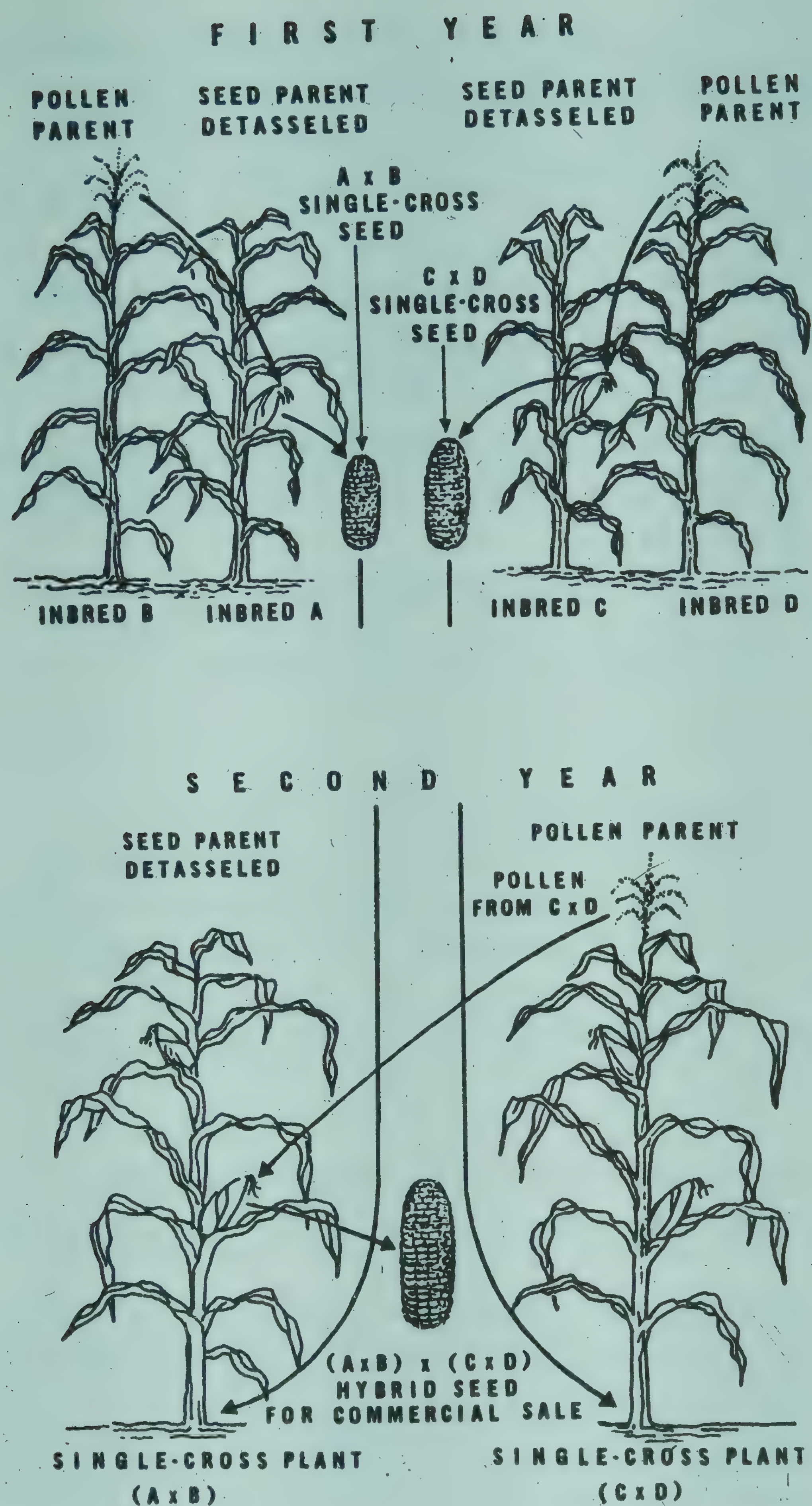

Fig 5.1. Production of double - cross hybrid seed corn using manual detasseling. The process begins with two pairs of homozygous inbred lines (A,B and C,D). Each pair is crossed (A X B, C X D) by planting the two lines in alternating rows and emasculating the female parent by manual removal of the pollen-shedding tassel (this process is known as detasseling). Only seed from the female parents is collected to ensure that no selfed seed is obtained. Plants grown from this single-cross seed are themselves crossed following the same procedure: (A X B) X (C X D). Seed is again collected from the female parent, and it is this germplasm that is the double-cross hybrid seed sold for farm production.[3b]

Why do Farmers Reject HYV's and Hybrids?

1. HYV's and hybrids are susceptible to pests and diseases.
2. They are not tasty, and their straw yields is less.
3. If the native varieties are grown with care, they are not less productive than HYV's.
4. In some agro-climatic conditions, the harvest of HYV's coincides with the rains, and hence much of the harvest is lost.
5. Harvesting of HYV's is labour intensive.
6. HYV's and hybrid seeds are expensive
7. The cost of cultivating HYV's is high. The recovery of even the costs is a myth.

Tissue or cell culture. This is among the most commonly used new technologies. Tiny pieces of plant material — tissue or isolated cells — are grown in an artificial medium that keeps them alive. Special hormones like rooting hormones, etc. help them to develop into complete plants. These baby plants are identical to the parent plant and to each other.

Tissue culture methods more than halve the time taken by traditional plant breeding methods as practised by farmers over centuries.

Cloning and fermentation. Cloning is the process of forming a cell culture starting from a single cell which can multiply itself. The culture thus contains cells with identical characteristics. Each of these cells can then be used to mass propagate new plants through tissue culture. Fermentation generally means a natural process in which the biological activity of a micro-organism (bacteria, or virus) is vital, for example, making yoghurt, wine, etc. Such processes using genetically engineered bacteria can produce vanilla, jasmine and citrus fragrance out of a totally unrelated medium, eg. ordinary edible oil can be converted into cocoa butter using this method.

Cell fusion and embryo transfer technologies are used mainly for dairy and livestock breeding purposes.

Recombinant DNA technology (genetic engineering). This technology involves transferring of genes from one cell to another. Genetic engineering crosses the boundaries of nature by allowing genes from one life form to be introduced into a totally unconnected life form, eg., genes from fireflies have been introduced into tobacco to create a variety that glows naturally; genes from a fish found in the Arctic Ocean have been introduced into soybean and tomato so that soybean and/or tomato plants can withstand cold and frost and also be refrigerated for long periods. Genes have also been introduced into plant varieties to make them resistant to a particular brand of herbicide.

Genetically engineered cells are mass propagated through tissue culture methods to produce thousands of new lifeforms with the new characteristics. Such life forms are often called transgenic.

The new biotechnologies are even more disruptive of the social fabric as they further distance the farmer from seed development. Any development takes place not merely in laboratories, but within the seed itself. The farmer becomes further dependent on outside agents for resources and information about how to use them.

The seeds produced by the new technologies are in no way superior to either farmers' varieties or to the seeds of the green revolution. By their very nature, they are monocultures, and will therefore have the same vulnerability to diseases and pests.

As their characteristics have been modified at the level of the gene, their progeny will have the same characteristics. Thus a plant that is engineered to produce its own pesticide will pass on this property to its progeny, who will continue to release it into the environment irrespective of any harm that it can cause. Further, products of genetic engineering have not been tested for adequate periods to see their long-

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Gene is a segment of DNA carrying very specific information about the plants. The number of genes may vary from a few dozen genes (virus) to tens of thousands (higher plants and animals). Some genes carry information for activating other genes. Of the few 100,000 genes of the tomato plant, which is one of the most studied, only around 300 genes have identitied so far. DNA is a molecule which is supposed to carry all the information necessary to create a new identical plant. The new biotechnologies assume that the DNA alone creates new life, and itself not influenced by any external environment. This has been the basis of conservation of DNA as "germplasm" of gene banks. However it has been shown that DNA cannot reproduce itself without the intervention of other necessary information and enzymes. It is thus influenced by the environment and continues to evolve by existing in the environment.

Third World Needs and the New Biotechnologies[5]

Basic Need	Potential contribution of new biotechnologies	Dominant research of biotech industry
	Crop production	
Conservation and improvement of diverse poor people's crops emphasizing hardiness, nutrition, and yield. embryos	Tissue culture technology could support conservation and breeding objectives.	Rather than pest resistance for pesticide the focus is on gene transfer for pesticide resistance, encapsulated and yield improvement for major crops only.
	Food processing	
Key concerns are durability, nutrition, and cost. Produce and production should be culturally and environmentally sensitive, making the best use of local resources.	Improvement of traditional fermentation methods and development of new possibilities.	Focus is on reducing or substituting-raw materials and the factory production of agricultural products.
	Animal husbandry	
Conserve diversity and broaden breeding efforts for foraging animals to develop healthier, more efficient livestock. Develop multipurpose domesticats.	Vaccines and diagnostics can support these efforts and embryo transfer can help preserve diversity.	Attention is on complete control over fertility and reproduction to develop high yielding uniform, but highly vulnerable breeds and also on veterinarial packages and on use of livestock as bio-reactors for drugs.

[5] Lachokovics, Eva. Homogenization of life: A summary of the problem/potential, Development Dialogue, 1988:1-2, p.51.

term effects on the environment. Once released into the environment, there is no way to recall these products.

Seeds in the World of GATT

GATT, or the General Agreement on Tariffs and Trade, now incorporates agriculture within its purview. The Trade Related Intellectual Property Agreement of GATT deals with the issue of ownership of seeds and other life forms.

Who are the producers of seed?

Today there are three kinds of producers of seed:

1. The farmer has historically been the producer of perennial varieties, which could reproduce themselves eternally.

2. Public sector research institutions have bred short-term varieties for "high yield". These seeds could for some time be saved and used by the farmer, but their yield reduces after a few years.

3. Transnational corporations produce non-renewable and therefore non-sustainable seeds through hybrids and tissue culture, where the farmer has to return to the company for fresh seed, each time ,he has to sow.

The last is called biological patenting of seed. Patents give the owner of the seed the exclusive right to multiply, save, develop further varieties and sell seeds. Biological patenting effectively prevents the farmer from multiplying, saving and selling the seed.

During the period when hybrid seeds are still being developed, the farmer still has some control over the seed. Agribusiness use **legal patents in agriculture** to take over this control.

Who owns seeds through patents?

According to the Indian Patents Act 1970, "patents cannot be given for a method of agriculture, of horticulture or for any process for the medicinal, surgical, curative, prophylactic or other treatment of human beings or any process for a similar treatment of animals or plants to

render them free of disease or to increase their economic value or of their products" (Art. 3h and 3i).

Many developed countries, which are the home countries of transnational corporations, grant such patents.

The TRIPs agreement, forces countries to change their national patent laws to bring it in line with the patent laws of developed countries. For instance, the Indian government has given a statement that Indian patent laws will need to be changed, though they insist that they have plenty of time to change them.

Farmer's Rights

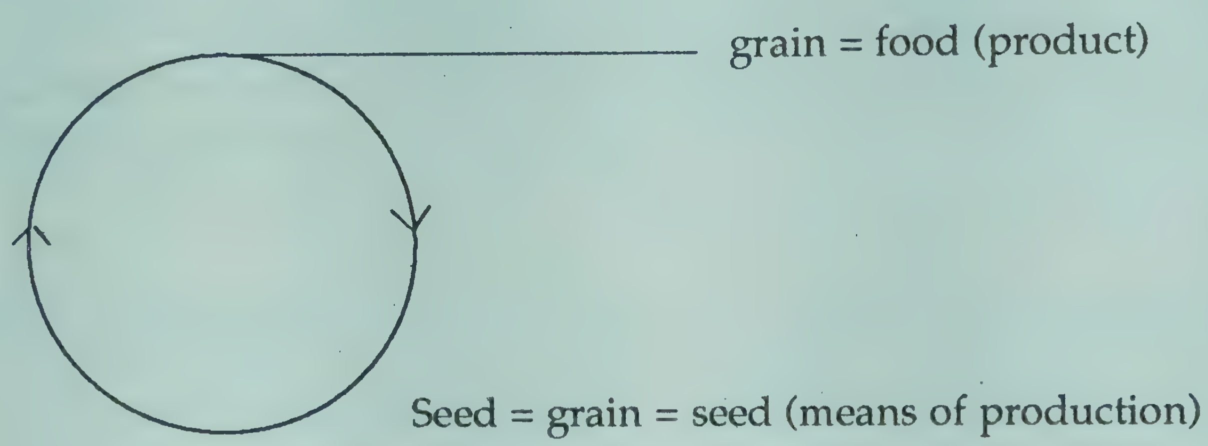
1. The right to ownership of biodiversity
2. The right to conserve, reproduce, modify, exchange and sell seed and plant material
3. The right to land
4. The right to feed and save the country
5. The right to just agricultural prices and public support or sustainable agriculture
6. The right to information
7. The right to participatory research

What are UPOV and Plant Breeders' Rights?

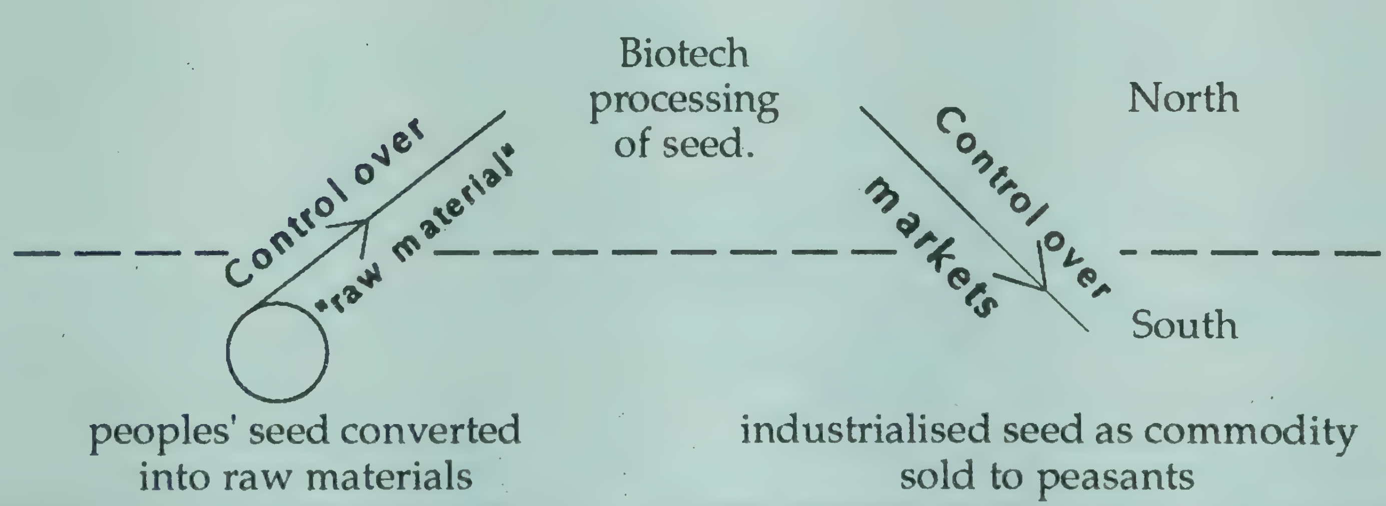
Other developed countries which did not offer patents, instead adopted the Union for Protection of Plant Varieties (UPOV) of 1978, also known as Plant Breeders' Rights (PBR). The earlier UPOV conventions gave control over marketing to corporations but did not give them control over the genetic material — the seed of the variety. Thus farmers and researchers were allowed to use this freely. In addition, farmers could save the seed and sell it. However, under pressure from agribusiness, the UPOV was amended in 1991 to prevent farmers and scientists from having free access to the seed or information about plants and varieties bred by the corporations. Breeders thus have complete control over the genetic material — the seed.

FIGURE 2. Biodiversity: 'Means of production' or 'raw material'

In traditional agriculture and forestry systems, biodiversity regenerates itself. It is both 'means of production' and 'product'. Thus, seed has been the source of grain as well as future source of seed.



Industrialised agriculture and the seed industry, especially with advent of the new biotechnologies, convert this seed into mere raw materials for seed as commodity, patented and privatised.



Can farmers still legally sell varieties developed and saved by them?

One of the first moves of the Indian government after signing the GATT agreement is to state that only "certified" seeds can be sold. The government claims that these seeds are not spurious. Farmers' seeds, which are not certified, constitute over 75% of the seed sales in India. Farmers' seeds are definitely not spurious, but individual farmers cannot afford the time and expense involved in certifying their seeds after each harvest. This measure of the government will thus make

farmers' seed sales illegal, thereby leaving the seed market open only to private breeders.

What is the alternative to patents under GATT?

Under GATT, though each country is given the choice to develop its own system (sui generis system) to protect plant varieties, the key word both in the TRIPs agreement and in the Biodiversity Convention is "**effective**". This effectivity, which will be judged by GATT and not by the country concerned, is interpreted to mean effective protection of the intellectual property rights of the corporation and not of the farmer. In international usage, this effective sui generis system is deemed to be UPOV.

With farmers being unable to sell, develop and modify seeds, the diverse seeds available in the country will increasingly disappear from the fields. As this diversity is not merely the repository of useful plants for agriculture, but is also essential for survival of all life forms, conserving this diversity becomes a survival imperative.

What a **sui generis** system, effective in protecting farmer's right to knowledge, seeds and biodiversity, should contain:

Any **sui generis** system for protecting farmers' rights to biodiversity and seeds should be addressed itself to the following imperatives:

1. **The ethical and ecological imperative to recognise the intrinsic worth of all species.** There should be strong legislation to allow exclusion of parents of life on grounds of public morality. This possibility is allowed in Article 25 of the TRIP's aggreement. Non-monopoly regimes which protect people's right to creative and innovation should govern the areas to be excluded from patentability.

2. **The imperative for equal recognition of creativity in diverse cultures.** Diverse cultures have evolved different tradition of knowledge and innovation which need to be treated with equal respect and significance. This is also needed for cultural diversity. In the area of biodiversity, indigenous knowledge of farmers, tribals, herbalists is the primary source of knowledge of property of plants. Collective intellectual property rights of communities and peoples should be developed which:

a: recognise this indigenous innovation, even though in structure, process and motivation it differs from the innovation in industrial systems:

b: through this recognition, the IPR/**sui generis** system prevents the piracy of indigenous knowledge of the biodiversity in which it is embodied.

3. **The economic imperative to provide all members of societies with health and nutrition.** This means that processes and products linked with food and medicine in agriculture, including seeds, plants, their principles, and processes for extracting them, and their products cannot come under monopoly.

Seed Satyagraha: Indian farmers' Movement against GATT

The Indian farmers launched the Seed Satyagraha at a mammoth rally in Hospet, Karnataka on October 2, 1992 in a bid to regain control over the seed and ensure its continuing freedom. This rally was followed by another in Delhi on March 3, 1993, where angry farmers burnt the Draft Final Act of GATT and forced the public to demand parliamentary debate on the issues involved.

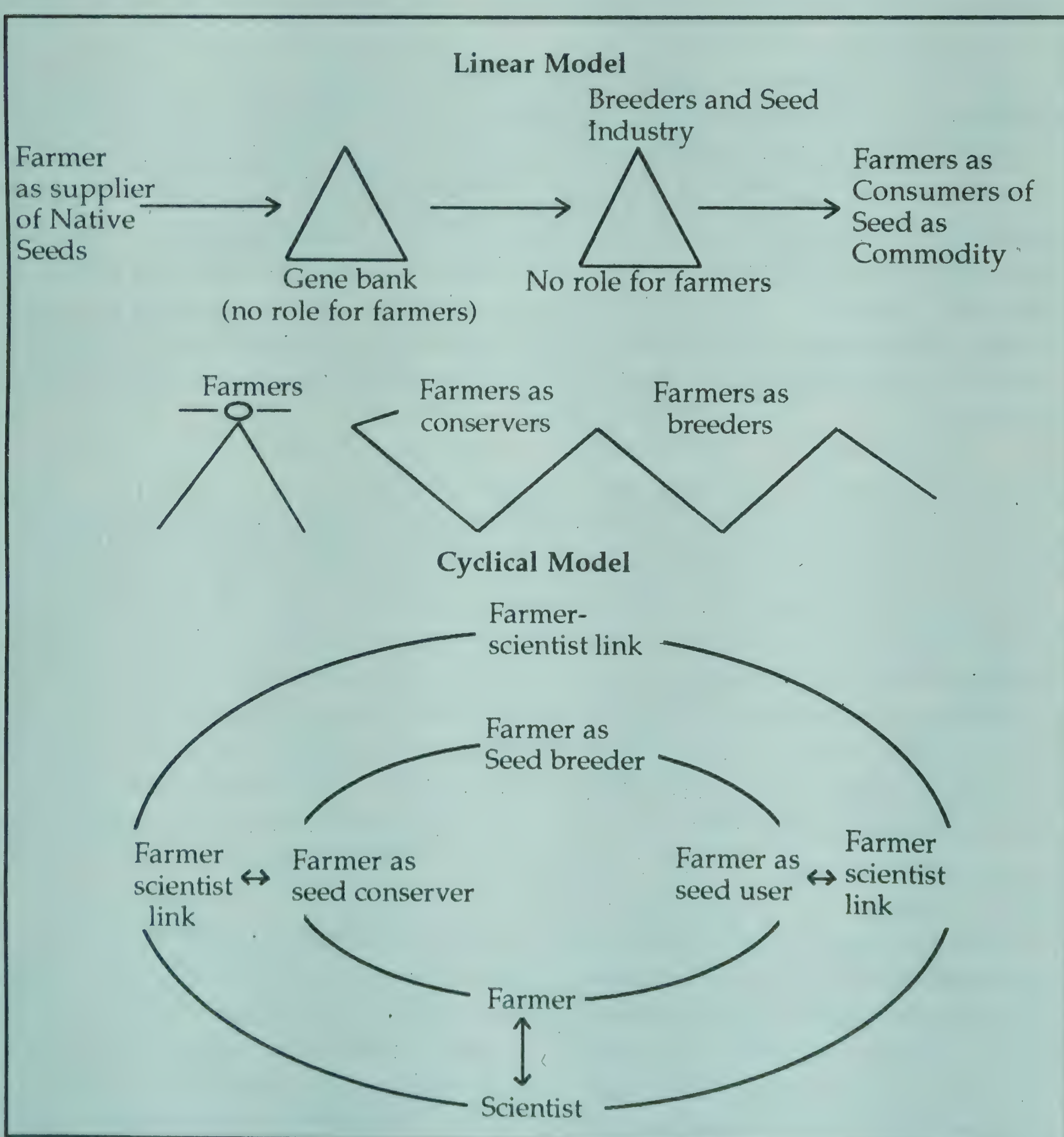
On 15th August, 1993, the farmers of Karnataka responded to the effective patenting of the active principle of the Neem tree - azadiracthin (through patenting of the traditional processes used to make available this principle) by declaring common traditional knowledge and resources as the Collective Intellectual Property of the community which generated the knowledge, innovated the technology and conserved the resources in the first place. This declaration redefined "piracy" to include corporations (both national and transnational) who stole this traditional wealth and patented it, and also shifted the burden of proof of "novel" innovation to the corporations. In addition, it gave the community the right to judge cases of piracy.

The October 2, 1993 rally was the globalisation of the Indian farmers' movement for seed freedom. Representatives of farmer's organisations from the Third World countries of Indonesia, Thailand, Philippines, Korea, Malaysia, Sri Lanka, Zimbabwe, Ethiopia, and Nicaragua took a pledge to continue the struggle for farmers' rights in their countries irrespective of whether their countries signed the GATT treaty or not.

CONSERVING BIODIVERSITY

The rate of ecological destruction and the accompanying loss of biodiversity has forced nations and international organisations to make efforts to prevent it.

There are two types of conservation activities. One type is farm-based, where the farmer conserves a variety by continuing to cultivate it regularly. This kind of conservation is called *in-situ* conservation. The second kind of conservation is when seeds and propagating material of plants are collected by groups of people (not necessarily farmers), and are stored in special gene banks again away from the field. This kind of conservation is called *ex-situ* conservation.



National and international efforts at conservation over the last thirty years have concentrated on starting and maintaining *ex-situ* collections, like CGIAR, NBPGR, IBPGR, ICRISAT, and the International Agricultural Research Centres, ignoring the fact that farmers have always conserved varieties successfully in *in-situ* situations. However, exclusive dependence on *ex-situ* cannot conserve biodiversity for the reasons given below. For a truly successful conservation programme, both *in-situ* or farm-based conservation has to be given primary importance.

It is known for centuries now that farmers felt free to deal with issues related to breeding according to their own needs while formal breeding system has to adapt their strategies to the needs of the commercial system. And this puts strict restrictions on how a plant breeder can work.

Institutional breeding reach farmers after the seeds have undergone a number of intermediate stages. Stability of the varieties is a main criteria for the formal system and it is achieved through uniformity and gives no room for diversity. Institutional breeding is an expensive way of breeding and needs an expensive seed supply infrastructure . For the same reason it is difficult to breed number of varieties and as a result it becomes essential to breed for wide adaptation. This is done at the cost of compromising the best local adaptation. On the other hand farmers select seeds for their own use and are therefore concerned about local conditions.

Farmer's breeding systems have implications for crop evolution. The two important aspects of crop evolution are 'change' and 'slowness'. Farmer's varieties perform under given growing conditions, cilmate,management and pest regime and this will be favoured by natural selection . Varieties evolve according to changing land use and modification of croping patterns. It is so with respect to climate and rainfall patterns as well. A particularly important aspect of this is the co-evolution of crops and their parasites, says Trygve Berg. In case of modern systems there is no room for evolution of varieties. Even when disease-resistant varieties are released; the actively evolving populations of parasites sooner or later manage to overcome the resistance. Once this is broken, the diseases spread like wild fire in uniform varieties. The second aspect of evolutionary nature of on-farm breeding is the slowness of progress.This aspect gives farmers time to observe and make adjustments and to absorb the innovations into their farming and food systems. Farmers who select thir own seeds, use a method called mass selection. This means selection of individual plants according to assessment of performance or appearance. If the farmer selects his seeds

from the most fertile patch of the field , it may not be efficient in terms of genetic diversity, but will still ensure the highest possible quality with respect to physiological seed development.

Limitations of Gene Banks

Gene banks are incapable of conserving biodiversity because the philosophy or ideology behind such conservation systems itself is based on three main flaws and inadequacies: scientific flaws, technical inadequacy and political inadequacy.

I. Scientific flaws: The concept of gene banks rests on the assumption that the genetic material of plants (called germplasm by those who accept this theory) can exist independent of the plant itself and that the environment has no role to play in determining or affecting in any manner the characteristics of the variety. (see Politics of Language, p.5). This assumption has been proved false. Further, stored in low humidity and at below zero temperatures, the seeds are removed from the process of evolution. Literally frozen in time, the life of the variety will depend upon its ability to adapt to gene bank conditions rather than upon the characteristics which made it worth storing. Thus the loss of diversity within gene banks is as great as, if not more than, in farmers' fields.

II. Technical inadequacy: *Ex-situ* gene banks are totally dependent on high-technology which is costly, often far beyond the capacity of many Third World countries. Technical failure and/or lack of financial resources can lead to the loss of seed varieties within the gene bank.

III. Political inadequacy: Seeds that are stored in gene banks are technically available to farmers, public sector research institutions as well as to the private sector. In practice, individual farmers do not have the same access to these banks, most of which are in developed countries as they lack the required time and resources to get the seed. At the same time, private seed companies with their vast resources and branches in various parts of the world can easily get the seed, and then patent any modification. Thus while the farmer "donates" the germplasm freely, the same is often sold back to him as the property of the company that has patented it.

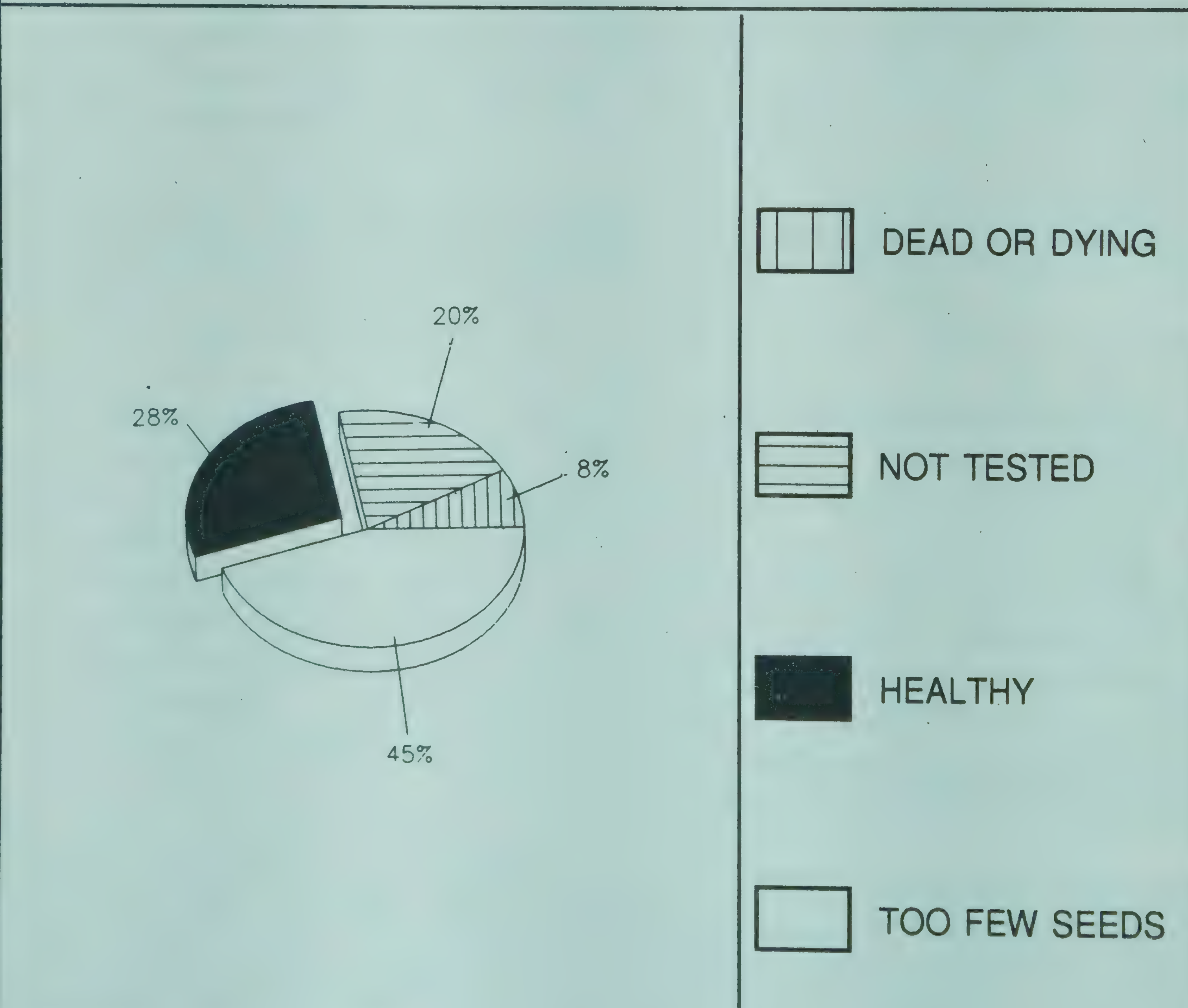
The same inadequacy exists even on a national level. Establishing and maintaining gene banks is costly. Hence, of the 127 base collections of the International Bureau of Plant Genetic Resources, only 17 are in the national gene banks of Third World countries. The latter countries are expected to donate genetic material for conservation purposes to the international gene banks, which are situated mainly in the Northern

countries, and often are supported by private corporations through funding. However, when it comes to access to such material later, the Northern countries become donors of genetic material from gene banks.

The largest gene bank in the world is the U.S. National Seed Storage Laboratory (NSSL) in Fort Collins, which stores 232210 seed samples. Of these only 64,036 or a meagre 28% have been found to be healthy. Almost three quarters of the collection have not been tested in atleast 5 years, contain too few seeds to risk testing or do not meet the U.S. Standards for viable seeds. Major Goodman a crop geneticist at the University of North Carolina has said "I would maintain that these banks are seed morgues. What goes in, isn't going to come alive", *

FORT COLLINS: BANK OR MORGUE?

OF ALL SAMPLES, ONLY 28% FOUND HEALTHY



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In-situ Conservation: The Only Alternative

An alternative biodiversity conservation is therefore necessary to ensure that our rich plant diversity continues to offer us ecological and economic security. This conservation starts and ends in the farmers' fields. Such conservation is also known as *in-situ* conservation, where conservation is carried on within the environment where the diversity grows.

In the conventional *ex-situ* gene bank model, the farmer is merely a supplier of the genetic material to be kept under high-tech conditions for future use by breeders and seed companies. He is totally distanced from his role of plant breeder. The only other role envisaged for the farmer is that of a consumer of seeds which itself turns into a commodity for feeding the non-agricultural populations.

In-situ conservation, by placing the farmer at the centre of conservation; reinvests, in him control over the political, ecological and economic aspects of agriculture.

The Political Aspect of Control. On-farm conservation returns to farmers control over decisions that govern their lives; and to nations (particularly Third World nations) over issues of sovereignty.

The major threat to both national sovereignty and farmers' independence — control over knowledge and resources — comes from an international political order that is based on unsustainable market economy and is determined by a few Northern transnational corporations and their governments. This has resulted in a free flow of both knowledge and resources from Third World countries to the Northern countries, with no reciprocal free flow of any modification or development based on these resources and knowledge. As diversity continues to erode in these countries, the options open to both Third World farmers and their governments reduce till they become totally dependent on the TNCs for resources and their governments for aid to buy these resources.

In-situ conservation provides Third World farmers and their governments with the diversity needed for keeping open options that would otherwise be closed to them. It also helps in identifying the owners of diversity so that the inequitable and unjust one-way free flow could be stopped. On-farm conservation not merely gives material reality to farmers' rights, but strengthens the hands of Third World governments when dealing with issues that affect national sovereignty.

Food Security. Food becomes a political weapon in the hands of industrialised countries against Third World countries. When the genetic base of food crops grown in the Third World is narrow, and available only from public sector institutions and/or private companies, the food security of the country is vulnerable. Conservation of biodiversity in the farmers' fields is an important step towards ensuring food security of the country as well as political independence.

Ecological Aspect of Adaptability and Sustainability. Farmers' varieties, which have suffered the most serious genetic erosion in the last 20-30 years, have evolved and are adapted to conditions of traditional agriculture. They are tolerant to environmental fluctuation. The genetic variability of these varieties provides some in-built insurance against hazards of disease and pests, a protection which is enhanced by traditional agricultural practices like mixed cropping. Thus they are adapted to subsistence and sustainable agriculture.

* Planting Niger as a multicrop in the drylands along the border keeps pests away from the main crops like Ragi.
* Marigold planted in the fields along with food crops plays a similar role.

Economic Aspect of Seed Supply. The destruction of people's livelihoods and sustenance goes hand in hand with the erosion of biological resources and their capacity to fulfil diverse human needs while regenerating and renewing themselves. *In-situ* conservation entails a shift from making uniformity the logic of production to making diversity the logic of production. It not merely meets various human needs, but regenerates and renews itself through the seed that is conserved.

When diversity forms the logic of production, external inputs becomes unnecessary to a large extent. Some varieties are grown for their straw/fodder value, others for their disease or pest resistance, and yet others for their adaptability to climatic conditions. Thus inputs of chemicals as fertilisers and pesticides are reduced as also the need for water. By shifting away from the concept of weeds, many greens and other nutritious herbs are retained on the field and can be used, cutting costs.

Mixed cropping acts as an insurance against the failure of any one crop and provides food and some income throughout the year. Last but not least, it continues to maintain the diversity needed for further development of varieties.

On-Farm Conservation: The Navdanya Experience

Three kinds of citizens' action exist in India to protect biodiversity:

* cultural
* political
* activity like Navdanya's conservation programme which is a bridge between the above two.

In cultures that have conserved biodiversity, **cultural action** that continues the tradition of conservation is the most effective means to protect the richness and variety of life. An example is the "Akti" festival of Chattisgarh, which is a centre of diversity of the Indica variety of rice. On Akti day, farmers worship their diverse paddy varieties at the site of the village deity. The rice varieties are then shared among farmers. The ritual reinforces many core principles of biodiversity conservation:

- it is a celebration of diversity
- it is a celebration of the renewal of diversity
- it reinforces the principle of seed as a shared resource, not private property. This is in complete contrast with a statement of a Cargill executive who claimed that the company had succeeded in 'stopping bees from usurping the pollen'.

The cultural approach is reinforced by **political action** to stop biodiversity destruction and to resist the takeover of control over resources and knowledge. This is symbolised by the SEED SATYAGRAHA movement launched by the farmers of Karnataka on October 2, 1992. The farmers, besides stating that they would not accept private ownership of life forms through the Intellectual Properties regimes, have continued the fight to keep the seed and the farmer free, particularly through the declaration of community ownership of natural resources and knowledge about them.

The national network of biodiversity conservation, started by Navdanya, **bridges the cultural and political actions** by setting up farmer-run genetic resource conservation centres and seed supply systems. Navdanya's efforts in this direction has found expression in basically creating linkages at three levels:

- the farmer to farmer linkage
- the farmer to scientist linkage
- the farmer to consumer linkage

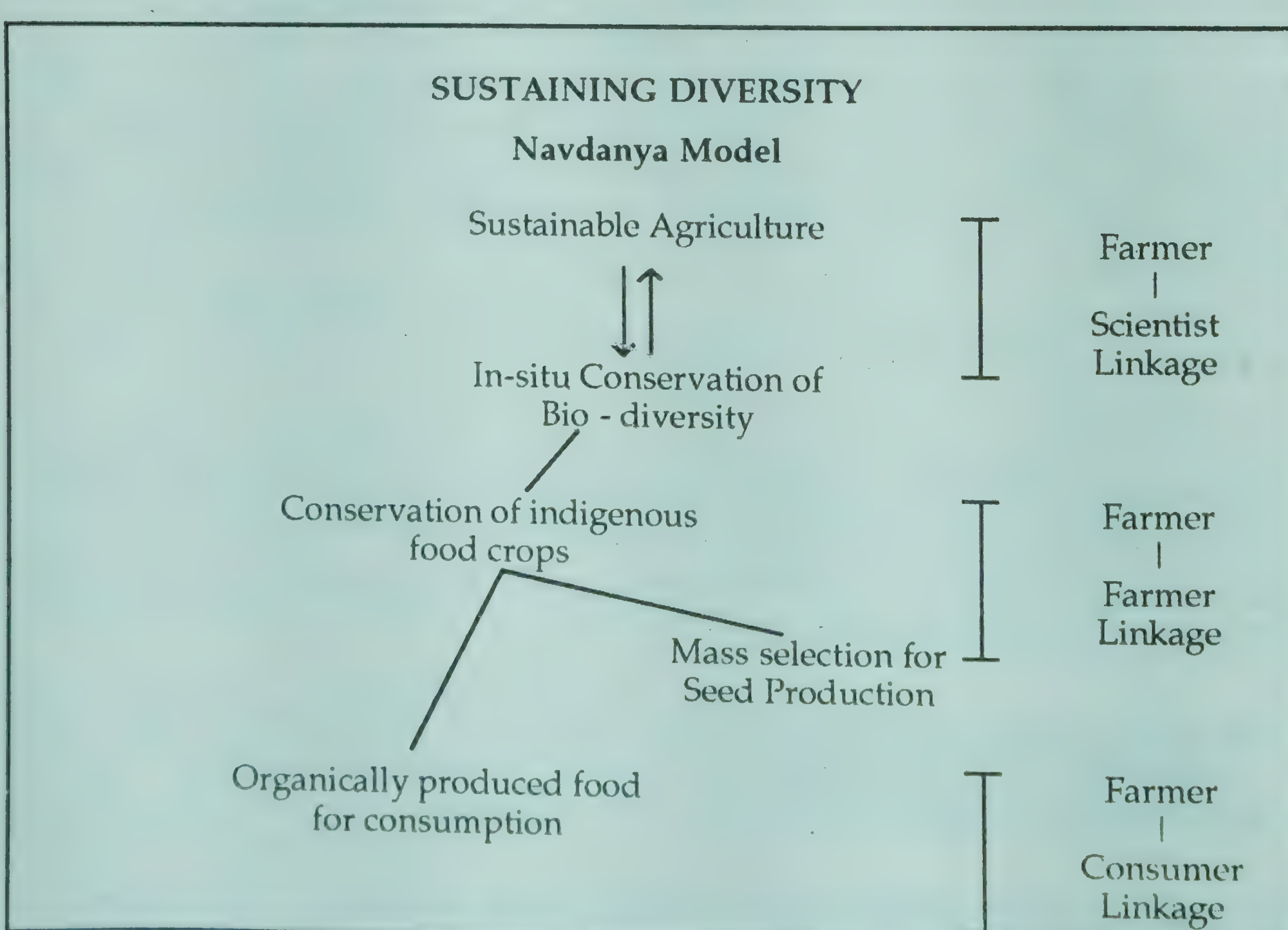
Navdanya's seed conservation programme reinforces the farmer's

primary role as plant breeder and conserver. The farmer is at the centre of a network model of conservation built on existing traditional farmer's exchange networks, while invigorating them with new relationships and knowledge derived from experiences in the formal system.

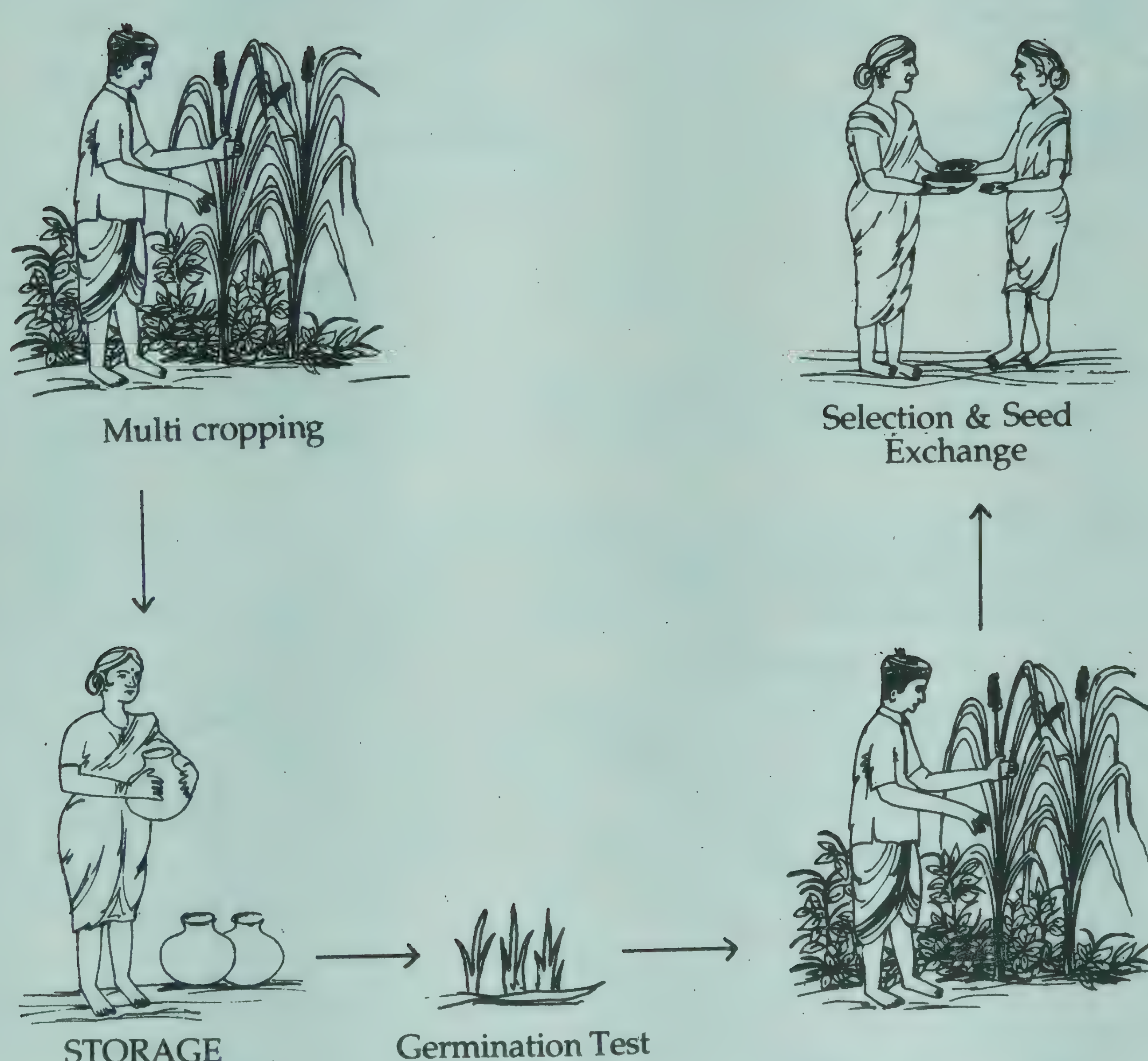
In such a model , conservation is no more separated from production and seed supply; it becomes a part of production and seed supply. In this model it becomes possible to locate intellectual rights. The seeds collected from farmers' fields are stored in **Beej Samrakshana Kendras (centres for protection and conservation of seed)** as *ex-situ* collections. They become locations of *in-situ* conservation when they are grown out for characterisation and utilisation.

In-situ conservation by beej rakshaks

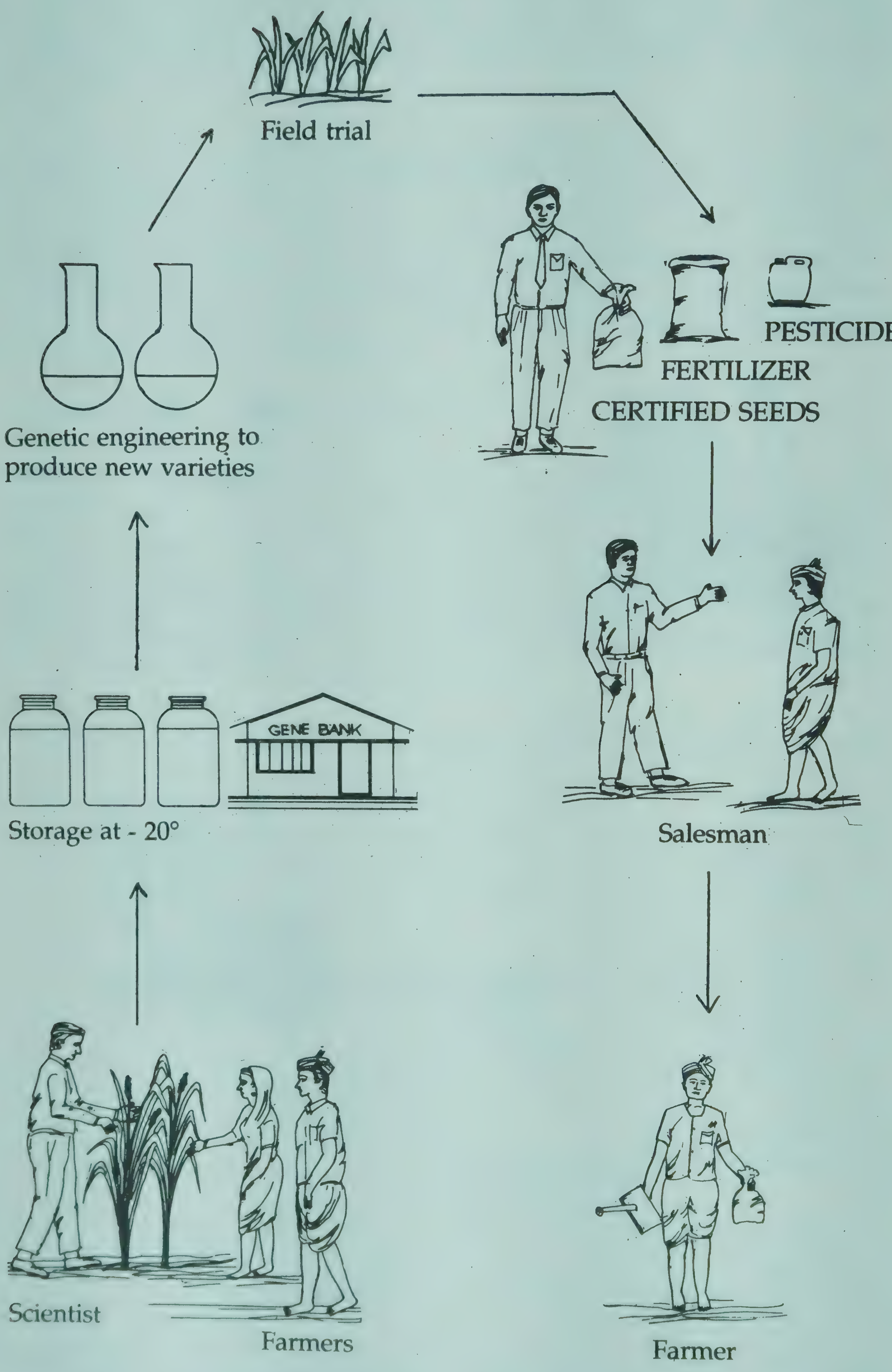
These seeds are given to **beej rakshaks (seed protectors or conservers of seed)** — either the original farmers, or those whose fields closely resemble the original site for *in-situ* conservation. Certain considerations are kept in mind while selecting beej rakshaks. For example, if 20 farmers' fields have similar soil conditions, the ones in drought-prone areas or waterlogged areas will definitely be included, because seed grown by them will be among the hardiest.



In-situ Conservation



Ex-situ Conservation



Precautions to be considered in conservation of indigenous material at ecologically appropriate locations.

* The location should be representative of a stressed area.
* The farmers' fields, where traditional practices are followed, should be selected.
* The size of the *in-situ* plot should be left to the beej rakshaks
* The material for *in-situ* conservation should be the original seed material that local farmers grew, to represent the 'population' structure developed and adapted over the years.
* For each crop species a number of *in-situ* sites should be taken, based on the uniqueness of the area across the region, the crop has traditionally been in production.

The three components on which *in-situ* conservation should be based are: time, location and materials.

Production of Seed by Beej Utpadaks

Seeds grown by the beej rakshaks are given to **beej utpadaks (producers of seed)** for the multiplication of selected seeds.

Seed material from the beej rakshaks should be selected following the simple "mass selection" (irrespective of the plant's physical characteristics) based on the criteria that the farmers have developed.

This process should be repeated over a number of seasons until improved populations are established. This would be the material that is multiplied for seed supply. The cultural practices to be applied on the selected or elite material would evolve along with the improvement from the mass selection.

Mass selection helps to :

- **capture physiologically well developed seeds.**
- **maintain the seed varieties as they are.**
- **improve the varieties.**

The culture of seed collection is demonstrated well when a family sitting outside the hut shells groundnut. Every single pod is cracked by hand and every single seed passes through the hand of one of them. Not one escapes their eyes. If any seed deviates from the normal it will be detected and discarded.

Seed Distribution by Beej Vipanas

The seed produced by the beej utpadaks would be distributed through the **beej vipanas**. These would be manned and administered by the local farmers' organisation.

To sustain the seed supply and to complete the cycle of regeneration, a market intervention to create demand for organic foods and native seeds is the final link in the chain. This last link also reinforces the first — the farmers' right to save, modify and sell seeds.

Conserving Diversity on the Field: Some Dilemmas

In-situ conservation by farmers and farmers' seed exchange systems in today's market orientation, and changed food values, bristles with problems.

Apart from the already mentioned major differences in the two conservation systems, the *in-situ* conservation is based on the farmer's choice of traditional varieties according to the criteria spelt out by them and to be utilised by them. Therefore the focus is to revive such varieties and to conserve them in their live form on the field. Such an approach towards conservation emphasises the broad genetic base conserved in each species and variety.

Therefore every step in the seed conservation activity has to be carefully planned to reflect the very unique purpose of conserving this genetic base.

At every linkage there are problems that need to be resolved.

1. Genetic diversity is vast. What are the limits of conservation for each programme? These will need to be resolved by each conservation programme for itself, given its own constraints.

2. Whether or not to give incentives in any form to farmers involved in such conservation; are such incentive schemes sustainable?

3. Organising seed supply between farmers beyond the initial stage. One possible resolution could be working with large farmers' movements and organisations.

4. How can one ensure adequate price-support for farmers in the programme.

5. Agricultural ecology today is greatly eroded. The myth of high productivity of the new seed varieties has been taken as a fact by many farming communities, and people have lost confidence in their own traditional technologies and productivity. There is a need for identifying and motivating sensitive scientists who will give the farmers the type of support that they need.

6. As the demands of the 20% urban population controls the production pattern, creating awareness among them about the nutritional and safety values of traditional organically grown foods.

There is no one model of *in-situ* conservation that addresses all these issues satisfactorily. Each conservation programme has to define for itself what its limits are.

Finger Millet

Finger millet was developed in Africa from Elusine Coracana Subsp africans probably in the Ethiopian region. It was introduced in India more than 3,000 years ago. It is a tropical crop, grown from sea-level to 3000m above sea level. In India, finger millet is cultivated in many states - Karnataka, Tamilnadu, Andhra Pradesh, Orissa, Maharashtra, U.P, Bihar and Gujarat.

CONSERVING DIVERSITY IN FARMERS' FIELDS

The specific characteristics and traits of a plant variety is contained in its seed. The formal system calls a survey of regions to find out the pattern and extent of distribution of species, varieties within species, or survey for rare genetic materials (such as medicinal plants, drought resistant plants, etc.) for the purpose of collecting, preserving and utilising this genetic diversity as **germplasm exploration**.

If conservation of genetic diversity in farmers' fields has to be effective, it must be carefully planned. The various stages in organising a farmer-run conservation programme include:

a. Planning

b. Collecting and documentation

c. Seed treatment and storage

d. Testing for seed viability and grow-out

e. Evaluation, characterisation and multiplication

f. Utilisation

In a farmer-run, community based conservation, many of these steps overlap, depending upon :

* whether the species is almost extinct
* the extent to which HYVs and monocultures have spread
* the economy of those areas where biodiversity still exists is a biomass economy, not cash economy. While *ex-situ* depends on financial status of the programme, the community seed banks have to build on the non-cash economy of traditional agricultural communities. Planners have to be very careful not to disrupt the economic balance of those societies through their intervention.
* priorities of the local communities.

Unlike a formal collection for gene banks, controlled by scientists, a community-based conservation programme constantly adapts itself to the various needs that may crop up. The collection and documentation can therefore vary from programme to programme.

I. PLANNING

Like any other activity, conservation programmes need careful planning to ensure that the collection is done in appropriate seasons by knowledgeable people.

This requires proper knowledge of the agroecological conditions in relation to the distribution of all the diversity in the region. It is also important to know the cropping pattern and crop calendar and the changes that have occurred over the years. In addition where the activity is being undertaken not by the community itself, but by an NGO working with the community, it is important to understand the cultural relationship that communities have with their seed in order to not violate their cultural norms and patterns.

Survey

A survey of the *whole* region is the first step to identify the varieties that are grown, that have become extinct, or are in the processes of becoming extinct as far as the formal system is concerned.

Surveys also need to keep in mind the various ecosystems within the region. Sometimes, even within short areas of 20sq. km., different microecosystems exist (slope, sunny area, shady area, near a water source, on banks of rivers, etc.). Even if a same variety grows in these different microecosystems, each should be counted as a separate variety.

Special attention should be paid to backyards, kitchen gardens, etc. where threatened and/or rare species may be grown for personal use.

In places where HYVs and hybrids have spread, resulting in changes in cropping patterns, diversity may be less. Special efforts are required to reach interior villages to identify farmers who continue to grow traditional varieties.

Surveys help in establishing local contacts with farmers who are growing traditional varieties, and involving them with the conservation programme.

A survey can be an expensive proposition if the farms are off the main roads and/or in places inaccessible to planners. However, as Navdanya works with farmers organisations and uses farmers' meetings to discuss

and plan priorities and varieties to be conserved, such a survey becomes unnecessary, as farmers themselves know who is growing what in their areas.

Reinforcing Farmers' Knowledge through Strengthening Documentation

Farmers' traditional knowledge of characterisation is being eroded by both the denial of importance, as well as the entry of new technologies. Community seed banks provide the opportunity for reinforcing this knowledge through strengthening documentation and characterisation.

While *ex-situ* gene banks merely relate to farmers as suppliers of genetic material, community seed banks have to treat farmers as informed subjects and not as objects. However, given the pressures under which traditional agricultural societies are functioning in which the formal system is eroding their knowledge and their confidence in their knowledge systems, a reinforcement is essential to stop that erosion. Without the external pressures which lead to farmers forgetting their seed conservation and production systems, the informal systems would survive on their own. Information gathering is therefore part of an empowerment strategy to strengthen farmers' knowledge systems and help them regain control over seed supply. In this documentation plays a major political role.

Documentation takes places at almost all stages of the programme. The conservation of seeds is of little practical importance if there is not information about their characteristics. Therefore it is necessary that information gathered during the preliminary survey and identification, collection, multiplication, storage, evaluation etc. are well documented.

In choosing the characteristics to be documented, the farmers' preference is most important. For example, the important characteristics of rice like leaf width, rooting characteristics may have some importance but this may have no immediate or primary importance to farmers. Characteristics which are important to the farmers must be well known. What criteria can farmers choose?

These mostly include gastronomical data, processing and storage information, agronomical data, morphological data, and details such as yield, quality, resistance to diseases and pests, adaptation to the environment and cultural value.

Some of the morphological data such as plant height, leaf width, etc.

cannot be collected at the time of harvest (since these collections may not be done while the crops are on the field), as the farmers may not be able to remember and give the exact details. Farmers again may not have the time or facilities to document the information, and the NGO may be constrained during growing time by distance, rough terrain, bad weather, etc. In such cases, minimum information is collected during interaction with farmers. The rest of the data can be collected during the multiplication stage.

Barnyard Millet

Is cultivated in India and in many parts of the Far East such as China. Japanese barnyard millet was domesticated in Japan 4,000 years ago. This minor millet is the quickest growing of all millets, producing the crop in as little as six weeks. The plants grows to a height of .6 to 1.0 meter. Varieties are green or purple pigmented. The dehusked grain can be cooked like rice.

II. COLLECTING

In formal Collections, the collection missions can be either **specific/pointed** (aimed at collecting variability in a particular crop with specific attributes such as drought resistance, biopesticidal, particular threatened or useful species, etc.) or **general or broad based** (collection of maximum diversity of different crops occurring in a region and maturing at the same time).

In a Community Seed Conservation programme, which is confined to smaller geographic areas, it is not possible to collect all the threatened species. In such a programme it is not possible to lay down strict norms as to where, what and how much to collect. The reality of a small community based collection system is such that the scope for wide variations in collection sites does not occur. On the other hand, the focus is always on traditional varieties that are on the brink of extinction.

Where to collect

Since seed variation is a function of co-evolution of plants in diverse habitats, seed varieties will be diverse according to altitude, distance, separation by river systems or other natural hindrances. Further farmers' seed is not just a product of nature, it is also an embodiment of culture. Seed will therefore be different where local people are ethnically and culturally different, since they will have selected according to their diverse lifestyles and their diverse knowledge systems.

Where should a community seed bank be set up

The most critical factor in the location of a community seed bank is the existence of a community or group that feels the need to set it up.

Where should collections of seeds be made

From farmers and regions where indigenous cultivation practices are still prevalent and indigenous seed has not been displaced by green revolutions varieties.

Genetic diversity usually occurs where monocultures have not spread. In such areas, there may be many more sampling sites than in regions where monocultures have spread.

In the formal system, where a team of experts launch out to explore the

different regions, they prioritise the regions that are dry and waterlogged. The collections are done during the growing seasons and the number of collection sites will depend on

- the length of the growing season
- the relative abundance of the species to be collected
- ecological factors like roughness of terrain
- farming systems, etc.

But in the informal approach to build community seed supply systems it is not always possible to collect during the growing season. Most often the collections are done from the farmers' reserve of seed. There is not always the necessity to prioritise the sites of collection.

Which varieties should be collected

This depends on the farmers' needs for seeds of different crops. Unlike *ex-situ* collections which merely maximise collection targets, community seed banks have to relate the numbers of samples collected and the varieties with the specific needs that farmers have for specific crops varieties with specific characteristics. As a general rule, these include:

- high yield
- qualities like palatability, colour, texture, flavour, cooking time, storage, etc.
- high nutritional levels
- adaptation to soil and climate
- disease resistance
- medicinal value
- fodder value
- soil-enrichment value, etc.

Ex-situ collections focus on all categories of plant varieties including

- cultivated crops
- wild relatives of cultivated crops
- related wild and weedy species

However since community seed banks are not just conservation programmes but also seed supply systems, the focus has to be on cultivated crops.

Farmers have very sophisticated systems of distinguishing varietal diversity in individual crops. Very often the farmers' nomenclature in

local languages is also a description of the characteristics of the crop variety. Local names of crops are therefore a very good indicator for deciding what to collect. For example, while rice is just oryza sativa in Latin, some of the varieties of the Garhwal region tell far more about the variety: *palliopar* - from across the river; *latmar* - difficult to thresh; *gorakhpuri* - from the area around Gorakhpur; *basmati* - rice with fragrance.

Similarly in the case of ragi, Navdanya has collected varieties of ragi over the last three years (see Appendix A).

Diversity is even deeper than mere nomenclature since microclimatic factors contribute to further variation. Hence seeds collected from different ecosystems even when they have the same name should be treated as different varieties.

All traditional varieties that are threatened with extinction should be collected for conservation on a priority basis.

As a practical rule, take samples from the following situations:

1. Where the varieties are distinct

2. Where there is marked difference in elevation

3. Where a natural hindrance is met

4. Where the local people are ethnically and culturally different.

Cover every ecoregion within the field

How to collect

In building a community seed bank farmers' networks are the best mechanisms for seed collection. Farmers generally know who in the region still grows a traditional variety that in other places might have gone out of cultivation.

Seed collection can be done in the field when crops are mature or after harvest from the homes of farmers. In addition to farmers' selection processes, the following methods are adopted by collection missions of gene banks.

Look at the field population of a farmers' variety or mixed population and get a visual sense of its variation.

First take a random sample. Take a single plant harvest every few paces throughout the field.

Then collect seeds of unusual or noteworthy plants. Avoid swamping the collection with too many unique types. Only a small portion of the total sample should be represented by your conscious collections of these unique types.

Look at the plant as a whole, not only its fruit, or seed characteristics. Do not collect from only the best-looking or most prolific plants. Be careful to collect as much seed from low-bearing plants as from those that have many seeds.

If a sample contains seed-borne or insect infestation, keep the seed separate from other samples, or else the whole collection could be destroyed. Usually, such problems can be controlled with local practices. **Remember, seeds that can tolerate infestation and still bear fruit can be extremely valuable.**

> When collecting a representative sample of seed from a field, do not make value judgements about which seed should or should not be collected. You may lose valuable genetic material

How much to collect

> **Optimal Sample size**
>
> Cross-fertilised seeds:
> 10 - 12,000
>
> Self-fertilised Seeds:
> 8,000

The most important rule for how much seed to collect is how much the farmer can spare for the collection. If possible, collect enough of the variety to be able to store in two different locations, especially if the seed has to be grown out. As a rule, collect more seeds from cross-pollinated crops and medicinal plants; with trees that require grafting, take two to three cuttings from each randomly selected tree.

Seed Fairs as a way to collect Biodiversity

Navadanya organises seed fairs with farmers as a means of collecting and conserving biodiversity. Farmers are invited to bring seeds grown for several generations in their fields. Incentives like Savings certificates are offered for special categories of seed like rare varieties, varieties of medicinal plants and biopesticides. Farmers choose judges from among themselves, to decide on the authenticity and/or rarity of the seed variety. The Navdanya seed fairs are thus a celebration of the traditional knowledge and the scientific plant breeders role of farmers.

The seed fairs also provide a platform for farmers to come together to talk about their varieties, exchange knowledge and seeds, and to spread diversity. Such fairs also strengthen community linkages and farmer-to-farmer linkages.

Thus these seed fairs become a statement of independence of the farmers from corporate/state control.

Collecting equipment

Formal missions collecting diversity normally require the following:

1. Cloth bags
2. Plastic bags
3. Pair of scissors
4. Knife
5. Collection forms
6. Note book
7. Clipboard

In rural areas farmers normally improvise with materials and methods to suit resource availability and match it with their needs. They will use whatever containers they can find to collect and store seeds. Memory in oral culture very often is a substitute for paper. Instant documentation is not always necessary. However, the informal knowledge needs to be consolidated and documented at the level of the community seed bank. This can be done through meetings, dialogues, partnerships between NGOs and farmers etc.

Collection documentation

1. **Labels are essential**. Put moisture-proof labels on seed bags, jars or boxes, preferably both outside and inside. Keep a separate label or data sheet in file.

SEED CONTAINER INFORMATION	FILE/CARD INFORMATION (2 copies to be filed separately in case of loss or fire)
LABELS	
1. One outside seed container	
2. One inside seed container	
LABEL INFORMATION	
1. Local crop and species name.	1. Copy of label information.
2. Local variety name(s) location	2. Detailed description of sample
3. Scientific name	3. Storage locations and status
4. Farmer's name and address	4. Germination test and grow out records
5. Collector's name and address	5. Farmers and collections
6. Collection location (local description)	6. Unusual seed/plant characteristic
7. Date of collection	
8. Date of storage	
9. Location of further documentation	

2. **Keep the information brief but thorough**. Label information should be gathered while collecting, and should be brief.

   These include:

   * common and vernacular name of plant
   * the locality (including exact distance from well-known landmark)
   * date of collection
   * collector's name (and collection number if used)
   * donor's name and address

3. **Keep additional information in files.** This can include the scientific name, the altitude, etc., most of which can be filled in once the collection has been brought in.

III. SEED TREATMENT AND STORAGE

Seed is a living organism. Storage methods have to be suitably designed to protect it from attack of pests, rodents, mould and microorganisms.

Seed storage has been an intrinsic part of traditional lifestyles. Different communities in diverse ecosystems and with diverse cultures have evolved different ways for protecting seed according to how they live. For example, in typical village huts the kitchen fire fumigates the seeds which are stored in an attic above the fire, preventing disease, pests and moulds. When these lifestyles start to get disrupted and the ecological conditions for seed protection are no longer available within the everyday context of peoples lives, special care needs to be taken to ensure safe storage.

Cleaning of seeds

The formal system, after collection, follows some simple rules:

Check seeds for	-	debris
	-	infected or infested seeds
	-	seeds of other species

Clean the seeds immediately after registration.
When the seeds are very moist, the process of cleaning itself may damage them. They must first be dried within fruits.

If the seeds have been extracted from the fruits, and have juice or flesh adhering to them, clean them using cold water and brush to remove the adhering substances.

If mucilage surrounds the seeds, washing in water will not help; rub the wet seeds gently with coarse sand and then wash the mucilage off using a sieve.

Avoid treating genetic material with chemicals, especially those chemicals that cause mutation in the germplasm.

When seeds are collected from farmers' storage bins, especially if they are from the recent harvest, invariably the farmer has already done the cleaning, since the farmers' varieties as stored are ready for sowing in the ensuing season.

Storing of seeds

Unlike the traditional systems where seeds have been evaluated by farmers and seeds required in bulk are stored by individual farmers as per the traditional methods evolved over the years, the formal system requires that seeds with little as well as large morphological variations are stored in small quantities. Basically storage by farmers is for immediate utilisation, whereas the small samples stored at gene banks are for further potential exploitation.

The methods of storage differ accordingly. In the formal system, it is desirable to store about 3200 seeds for species with little morphological variation (genetically homogenous) and about 8000 seeds for species with large amount of morphological variation (genetically heterogenous).

> A Condition in Maize called *blue eyes infection* by penicillium breaks down the dormancy by releasing ethylene. the seed subsequently deteriorates rapidly.

Seed storability is considerably influenced by the type of seed. Some seeds are short lived, eg. onion, soybean, groundnut.

In general starchy seeds can be stored for a considerably longer period than protein/oil containing seeds can be, because of their hygroscopic nature.

Storage environment affecting seed longevity

The life of a seed and its capacity to produce a new plant is affected by moisture content, temperature and the amount of oxygen available to the seed.

For every 1% decrease in seed moisture content, its longevity is doubled. For every 5% decrease in storage temperature, its longevity is doubled.

Seed Moisture content	Effect on Seed
30 - 60%	Germination occurs when water is imbibed to these levels
18 - 20%	Respiratory rate is high; mould and insects become active.
13 - 17%	Respiratory rate is still high; mould and insects can damage; fumigation at this stage.
10 - 12%	Seeds store reasonably well for 6-8 months in open storage; insects can still be a problem.
8 - 10%	Can be preserved for 1 - 3 years; very little insect activity
4 - 8%	Safe moisture content for sealed storage
0 - 4%	Excessive desiccation (drying can be harmful)

The following table gives an approximate idea of the relation between seed moisture content and storage life:

Seed Moisture	Storage
11 - 13 %	½ year
10 - 12 %	1 year
9 - 11 %	2 years
8 - 10 %	4 years

While in the formal system fewer seeds of many varieties are stored as samples, in the community seed banks which combine conservation with production and seed supply, the varieties are fewer while the quantity of seeds needed is larger.

During our work, we have often stumbled upon issues like is there adequate space for storing these large quantities of seed even for short term. Linked with this are other questions like distribution of seed among farmers, mass selection for seed multiplication, which need to be thought through. Some of these questions may still remain unresolved in different situations.

Seed drying

Drying is simply the evaporation of moisture. Liquids at given temperature have a definite vapour pressure that tends to produce vaporisation. The moisture in a seed exhibits such a pressure. Water vapour in the atmosphere exerts a similar pressure. The drying of seeds takes place only if the vapour pressure of the atmosphere is less than

that of the seed. As the difference decreases, the rate of drying drops. Drying ceases when the difference between the two vapour pressures is zero.

GENE PARKS

Seeds of certain crop like Cocoa, Coffee, Rubber and Avocado, require high moisture content for their safe storage. They are also called **recalcitrant seeds**. Thus they cannot be stored like other seeds. Such seeds need to be stored in living conditions - *gene parks*

Gene parks can be used for growing rare and/or useful species like medicinal plants, and crop threatened with extinction.

The relationship between relative humidity (the vapour pressure of the atmosphere) and moisture content of seeds is as follows:

Relative humidity	70%	60%	45%	35%
Seed moisture content	14%	12%	10%	9%

Therefore, the need for special storage facilities depends upon the relative humidity in the region. For example, in Bangalore, the relative humidity is 10-15% except during monsoon. Seeds can be stored safely at room temperature. However, in relatively high humidity areas, it is difficult to keep seeds at a low moisture content without special storage facilities.

The ideal humidity of 45-60% permits seeds to be kept at 10-12% moisture for a sufficient period of time, say from harvest to planting.

Methods of drying seeds

Drying seeds within their pods helps to keep pests and insects away. The various drying methods include:

- Natural drying
- Sun drying
- Unheated, heated and dehumidified air drying
- Drying with desiccants such as silica gel, and other high-technology methods
- Vacuum drying and freeze-drying

Seed Treatment

- Seed treatment refers to protection of seeds from plant diseases, seed rot and seedling blights, storage insects and soil insects.

Traditional and non-chemical methods of insect control

Many natural additives like local plants, minerals and oil are used for treating the seeds. The insecticidal properties are often stronger in one particular part of the plant.

Grain

Black pepper	5% black pepper on wheat gives 100% proof against rice weevils
Cinnamon bark	Raw bark attracts rice weevils on addition of a few pieces to a sack of polished rice
Eucalyptus	The action is similar to the above, when the bark is added to a sack of rice
Fenugreek	Is mixed with grain in sacks
Vitex negundo	Leaves are used to protect sorghum and pulses
Neem	Leaf, fruit, seed are all used. 5 to 7 thick layer is spread over a large quantity of grain. Powder made from neem seeds is widely used with stored products. The powder mixed with wheat at a rate of 10-20gms/kg. of wheat protects against rice weevils for almost one year.
Red chillies	Protects rice against weevils. Burnt seeds were used to protect maize even 400 years ago.
Mint leaves	Powdered leaves mixed with wheat at 5% gives good control over rice weevils

Traditional methods of Controlling Insects & Pests

* The grain/seed may be periodically dried in the sun.
* The seeds may be sieved very thoroughly before storage. This will get rid of most of the debris.
* Local plant products are mixed with the grain. The plants used often are closely guarded family secret, but those known to be used include lemon and other grasses, bark of trees and pepper.
* Wood ash and sand may be mixed with grains. One effect of adding these is that is they fill the inter-granular spaces and so restrict insect movement. Sometimes small cereals grains, such as millet are added to maize and sorghum which is stored for seed.
* Adding inert mineral dusts and special types of clay to the grain is also practised. These scratch the thin water proofing layer which exists on the outside surface of the insect's body wall, causing a loss of water and its death from desiccation. Wood ash and sand can also have this effect. Sometimes the powdered dry rhizome of sweet flag (*Vacha baje* in kannada; scientifc name: *Acorus calamus*) is also added.
* Grain is stored in lofts, where the smoke from cooking fires can reach and drive away insects and pests. Often this method is used to drying seed also.
* Grain can be stored in jars and baskets which are made essentially airtight by sealing them. A small clay lamp filled with oil may be lit and placed inside the jar before it is sealed. The lamp will burn until the oxygen in the container is exhausted, so that insects also perish from lack of oxygen.

Turmeric rhizome	2% rhizome powder is mixed with wheat and rice
Wild tobacco	Dried, chopped leaves laid over the pulses protect it from bean weevil
Plant extracts	2-3ml. of neem oil mixed with 1kg. of beans protects them during storage from bruchid infestation. It is important to ensure that the oil is well mixed so that each bean is completely coated. Protection lasts about six months

Minerals:	
Activated charcoal	Effective against weevils
Fine sand	maize is mixed and covered with dry, sieved fine sand
heat activated clay dust	very effective against weevils
Ash:	
Acacia, casurina, cow dung ash, mango trees, rice husk, tamarind seeds	Is mixed with grains to give a protective covering

Seed storage

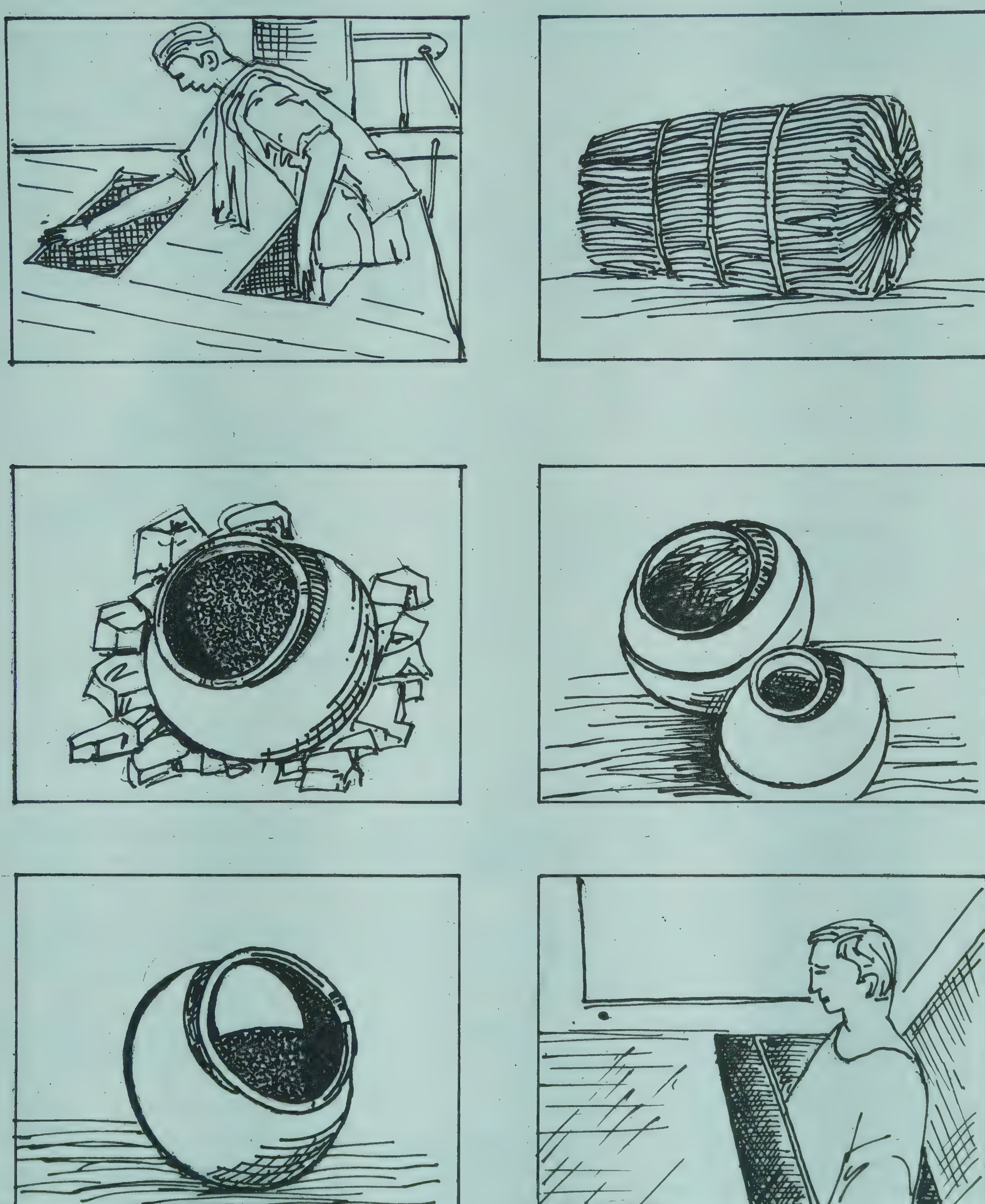
In the formal system, effective seed storage requires that:

- the storage is moisture-proof; this is essential to retain the seed moisture content
- the storage is rodent and termite-proof
- the storage is airtight
- the storage has low thermal conductivity
- the storage has facility for easy loading and unloading
- it is reasonably inexpensive to construct and maintain

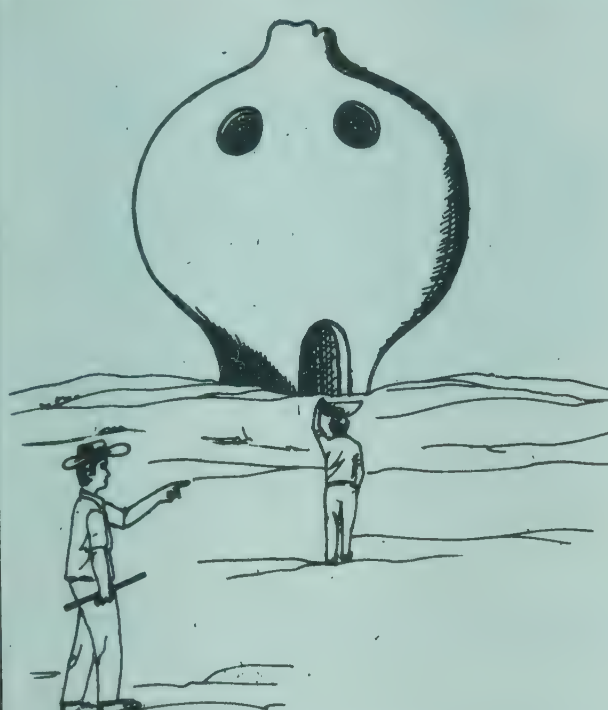
Moisture-proof containers include sealed tins or aluminum cans, glass jars with gasketed lids, and pouches of laminated aluminum foil. In situations where the relative humidity is maintained, or is low, the seeds can also be stored in paper envelopes.

Some of the traditional methods of storage existing in the rural communities take care to make the storage moisture-proof, protected from rodents and termites, and easily accessible for loading and unloading.

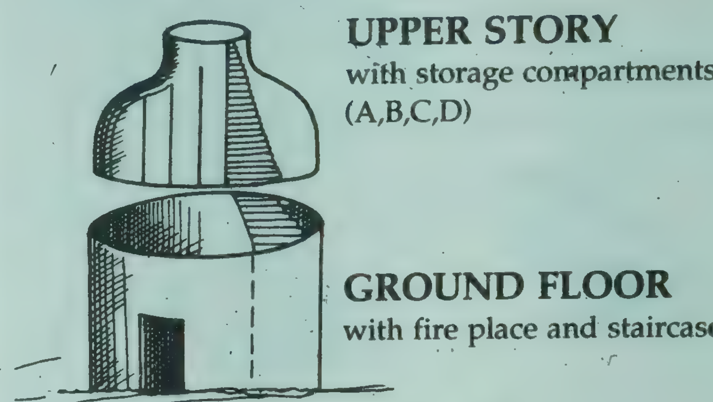
Traditional Storing Methods in India



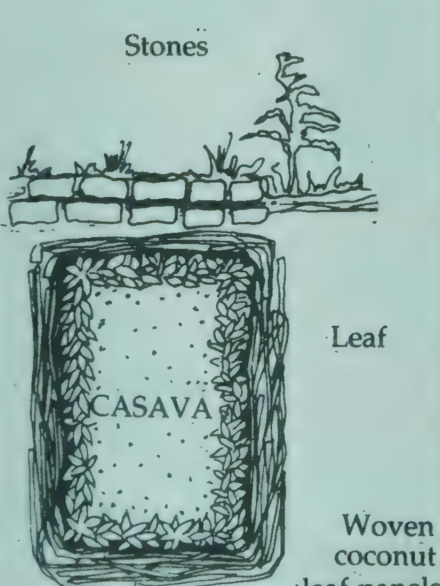
Storage Methods to protect grains



In **Northern Mexico,** closed clay Silos of this type will be found. If the lower opening is sealed with adobe and straw, the curved walls will make it difficult for the rats to climb the stucture.

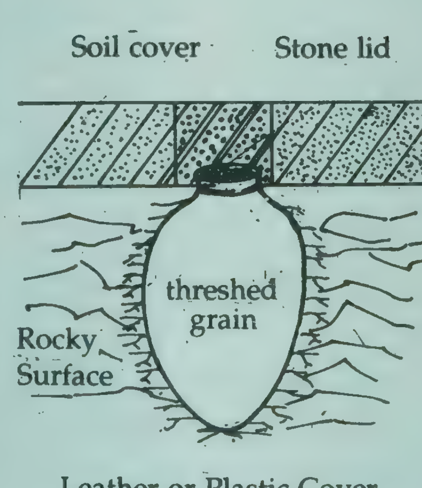


NIGERIA
Completed Runbu with thatch cover that can be raised and lowered.

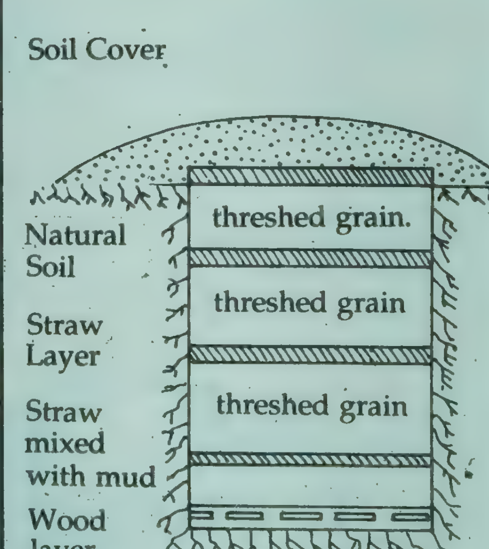


Fermentation pits can vary in size from 70cm diameter and 70cm deep to communcal pits used for storage in case of natural disaster and for use during feasts.

SOLOMON ISLANDS



STANDARD DESIGN OF A CONCEALED GRAIN PIT IN CENTRAL ETHIOPIA



STANDARD DESIGN OF A GRAIN PIT IN NORTHERN ETHIOPIA

IV. TESTING FOR SEED VIABILITY AND GROW OUT

Testing for seed viability (germination test or 'growing out") is the richest part of the whole farmer as conserver endeavour.

At the point when the sample is at its weakest (low germination and/or low seed count) divide it up and take a chance that it will multiply safely in the field.

Seed Germination

Seed germination is the active growth of the embryo resulting in the rupture of the seed coat and the emergence of a young plant. The capacity of the seed to germinate establishes its viability.

Factors influencing germination

Water, oxygen, temperature and light, all influence germination, although the first three are essential.

Water: The amount of water the seed can imbibe depends upon:

- its chemical composition
- the permeability of its seed coat
- the availability of water in the environment

While lack of water means a seed will not germinate, excessive presence of water also creates problems. It reduces the availability of oxygen to the seed, which in turn can cause abnormal germination, or failure of germination. Reduced oxygen availability can also increase microfloral competition for oxygen.

Oxygen: The seed uses up energy during the process of germination. This energy is produced by oxygen through aerobic respiration.

Temperature: Different seeds germinate within different temperature ranges. Very low and very high temperatures prevent germinations all seeds. The temperature of the germination test affects both the total proportion of seeds which will germinate and the time taken by the seeds to germinate.

Light: The seeds of most cultivated plants usually germinate well in the dark if they are not dormant.

Germination test period

Both within the population and between populations and species, individual seeds vary in the time they take to germinate. **The germination test period should be sufficient for every viable seed to germinate, including the slowest.**

Germination test

Check seed sub samples out every 3-12 months.

Place 10 to 100 seeds in rows in a moist paper towel and roll it up into a cylinder. Keep it in a paper in a warm sunny place. Moisten the paper towel every two days, or as needed. Check it for 6 to 12 days.

Check the total percent germination. **Whenever a seed accession (seed variety) falls below 50% germinability, plans should be made to regrow it.**

Traditional methods of seed testing

Women farmers, who are the custodians of the seeds, select the seeds from their storage and harvest, and conduct germination tests as a cultural and ritual aspect of farming. In Karnataka this germination test is built into the festival of **ugadi**. Seeds are sown in a flat clay pot or basket in wet sand, or mud from the field itself, and observed over a period of nine days. The germination of the seed is assessed on the 9th day. The pot is worshiped, and taken to a nearby water source, where it is floated on the water. If the germination is poor, the farmers do not use these seeds in the field, but borrow or exchange seeds with other farmers.

In Chattisgarh, the centre of diversity for the *indica* varieties of rice, women farmers have traditionally carried out germination tests in a highly scientific way. Twenty one seeds are tied in a small cloth bundle and put into the soil. After three days, they are checked for germination. If one or two seeds have not germinated, then the seed rate is increased accordingly. If more than three seeds do not germinate, the sample is not used for sowing.

Home-made Growth Regulators

* 10kg. of manure consisting of 50% cow dung and 50% green leaves and mulch put in bag, is dipped into a barrel containing 200 lts of water. The contents are kept covered for 3 weeks, and stirred every day for a few minutes to let some air into it. When the liquid is ready and odourless, 200 gm. of jaggery (gur) is added. One week later the growth harmone is ready. It is stored in an earthen pot away from direct sunlight.
* 1 litre of cow's urine is diluted with 5 litres of water. A bag of seeds is dipped in this mixture and then dried in the shade germinates well when sown.

Seed dormancy

If a viable seed does not germinate in conditions when it should normally germinate (presence of adequate moisture, temperature and oxygen), it is said to be dormant.

Treatments which remove dormancy

Dormancy in a seed reduces after ripening or post harvest maturation

- when seeds are stored in a dry (very little relative humidity) state
- when the outer covering of the seed is removed.

"Grow-out" of seed

1 Select appropriate soil and climate conditions for growing out. Consider where the seed came from, and choose a similar environment and planting time for grow-out. Otherwise, invariably, some of the genes which made that farmers' variety unique and special will be lost.

2 Keep varieties separate during grow-out to prevent it from being corrupted, if they are cross-pollinated crops. For example, if there are five varieties of chilies to be grown out, then make sure while planning plot sizes and layouts that there is enough space between such varieties to prevent cross-pollination. If such space is not available, grow these varieties one at a time.

3. The size of the grow-out depends upon **breeding orientation**: the number of seeds that need to be grown out to maintain the collection.

> 1. The more seeds there are on trees, the less are viable. Therefore more grow-out is needed. Eg., neem.
> 2. Seeds which pass through the intestines of birds and cows are viable, so less grow-out is needed

Genetic variation should be considered. The more "mixed" or diverse the collection in seed shape, colour, size, etc., the larger the grow-out needed.

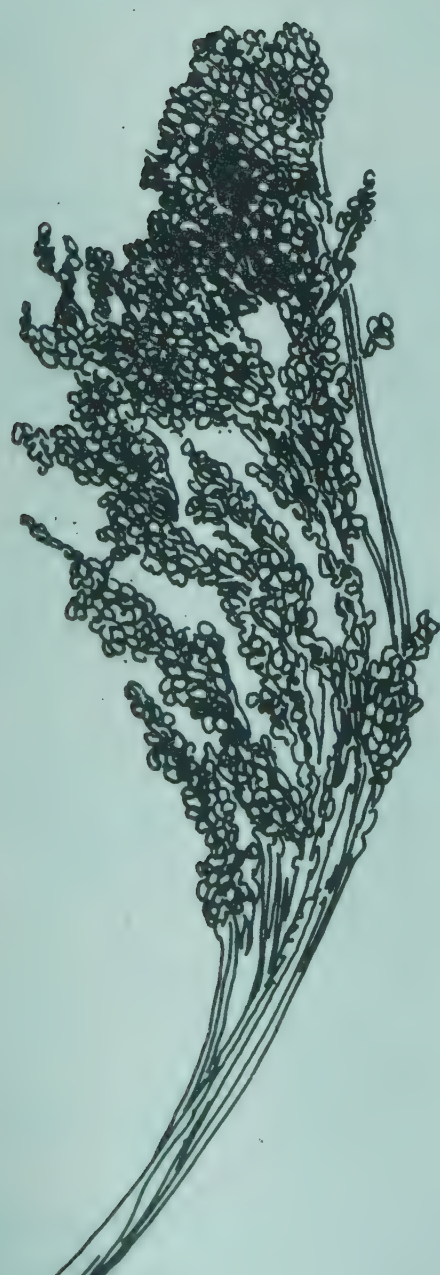
For example, an original mix of eight colours of beans would need at least 64 randomly selected seeds for a 99% chance of having all eight kinds represented. 250 seeds are a minimum to adequately represent the variants in a predominantly self-pollinated crop such as beans; for cross-pollinated crops like maize, plant at least 500 seeds and take equal sized samples from each earhead in the stored collection.

Do not re-collect only the "best": be careful not to select only the most attractive seeds from the grow-out plot. Diversity is essential. Take special care to collect a representative sample, or you will be guilty of selecting out and losing potentially valuable genes.

For tubers and tree cuttings:, take 2-3 offshoots from each parent plant. Given the limitations of space and other things, try to have as many individual plant progeny represented as possible.

Documentation

Signs and documentation are useful, including on-site signs and maps which clearly show what is being grown-out in which plots, so as to avoid confusion.



Proso Millet

It is one of the ancient crops. It was probably domesticated in central and eastern Asia and was cultivated in Europe in Neolithic times. This is essentially a crop of the temperate regions but is also grown in the sub-tropics. The plant grows to a height of .5 to .7 meters and tillers freely. The grain varies from grey, olive grey and ivory yellow in colour.

V. SEED EVALUATION, CHARACTERISATION AND MULTIPLICATION

The seed variety must be characterised and evaluated according to the farmers' requirements. Therefore the criteria for characterisation and evaluation must reflect these requirements. The following criteria are usually included in such characterisation and evaluation.

* Gastronomic criteria including:
  - taste
  - cooking time

* Preparation and processing opportunities

* Storage Quality

* Agronomic criteria including
  - ability to compete with weeds
  - variable maturity period
  - tolerance to drought
  - resistance to bird damage

* Morphological criteria include
  - grain and fodder yield
  - plant height
  - tillering potential

Evaluation of the genetic resources includes details such as yields, quality, resistance to diseases and pests, adaptation to the environment and cultural value.

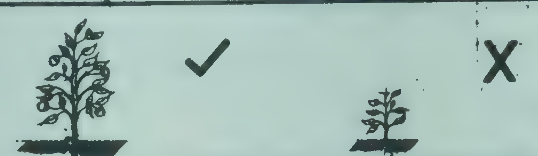
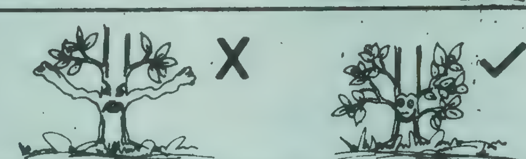
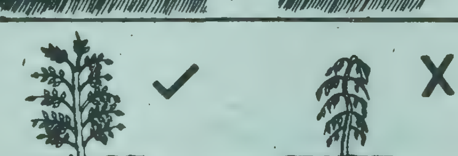
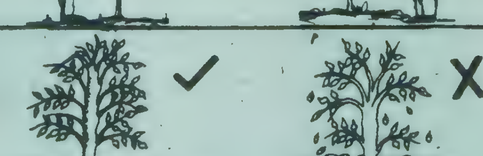
Documentation for characterisation

Passport data

This includes all basic information recorded by the collector — accession data, scientific, common and vernacular name of the crop, whether it is farmers' variety or wild variety, etc. For eg.,

Accession No.	0001
Scientific name	Sorghum vulgaris
Common name	Great millet
Vernacular name	Jowar (Hindi) Jola (Kannada)
Variety	Farmers' variety

Farmers' Criteria for Selection of Variety.

	Criteria for Selection		Selected Varieties		
			1	2	3
1.	High yield without use of external input				
2.	Early Maturity				
3.	Good eating Quality				
4.	Pest resistant				
5.	Medium Height				
6.	Drought Resistant				
7.	Strong Stems				
8.	Good tillering Quality				
9.	Erect Leaves				
10.	Big Grains				
11.	Non-Shattering				
12.	Cost Beneficial				
13.	Fodder Value				

Collection data

This includes collector's name, date of collection, site of collection, name of donor

Characterisation

Consists of recording those characteristics that are inheritable, and can easily be seen by the naked eye, such as growth habit, leaf and "glume" (waxy cover on the leaf), hairiness, plant pigmentation, pod shape, seed colour, etc. (see Appendix for Navdanya's chart)

Preliminary evaluation

This consists of recording additional traits thought to be desirable by the farmers for the given crop species. For example, germination rate, seedling emergences, days to flowering and maturity, plant height, etc.

These characteristics are observed in the field. For this, the plants are observed through all stages of their development and certain attributes of the vegetative and the floral parts are characterised at the right time and recorded in the right field book. **In many cases, this is best done during the grow-out period**.

For characterisation of each accession, a representative number of plants are randomly selected and the observed data is registered. The number of plants to be characterised is based on how they are fertilised (cross, or self)

* For cross-pollinated crops, the number of spikes or pods from species to species — 20 to 35 plants
* For self-pollinated varieties, 5 to 10 plants.
  (see appendix for list of cross pollinated and self pollinated crops).

Seed Multiplication

Multiplication of seeds is necessary to increase the number of seeds for conservation and utilisation. The collection accessions must be increased in suitable sites, taking due care of agronomic practices.

Some precautions to be followed during regeneration and multiplication

* Select site and soil type to closely resemble the original site the sample was collected from.
* Choose optimum sowing date, exact seed rate, appropriate spacing between plots and plants.
* Follow right cultural practices.
* Harvest at the right time of maturity, giving priority to shattering types.
* **Take special precautions to avoid seed contamination.** Seed contamination can occur through
    a. adulteration by foreign pollen coming from the neighbouring land. It is useful to know the breeding systems of crop types.
    b. Seed adulteration by mix-up with seeds of other types during planting, harvesting and cleaning.

In predominantly cross-pollinated plants, strict isolation is important to safeguard the integrity and identity of the variety. Bagging wind- and insect-pollinated crop species is one such method of isolation.

Characterisation, multiplication and evaluation of farmers' varieties of Ragi (Finger Millet)—a participatory approach

Minor millets are grown over 7 million ha. The varieties include finger millet, kodo millet, foxtail millet, little millet and barnyard millet. The grain production is about 5 million tonnes.

Finger millet alone is grown annually on about 2.6 million ha. producing about 3 million tonnes of grain. It is the staple food for millions of people in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Maharashtra and Bihar.

Ragi is rich nutritionally, being rich in minerals like iron and calcium. Its straw is highly valued as cattle feed, and farmers feel that the return from the straw alone almost compensates the cultivation expenses.

An example of participatory characterisation and evaluation of traditional ragi varieties undertaken by Navdanya with the farmers of Thali is given.

Varieties

Many varieties of ragi are known to exist. Some of them have however come close to extinction because of changing agricultural practices. The Navdanya conservation programme collected commonly grown native varieties like *majjige ragi, jenugoodu ragi, iyyana ragi,* including the more commonly grown varieties like *karikaddi ragi, hasurukaddi ragi, sannakaddi ragi, doddakaddi ragi,* etc. These varieties have been named by farmers on the basis of the nature of the earhead grain or straw quality.

As part of the *in-situ* programme, about 30 farmers in Thali block were involved in conserving some of the commonly available varieties of ragi. The rare varieties could not be taken up since seed availability was limited. Apart from ragi, some of the farmers were also involved in the conservation of rainfed paddy varieties like *doddabairu nellu,* and *mara nellu.*

Farmers were involved in evaluating the performance of the ragi and paddy varieties. This was an expression of their experience in growing these varieties as against HYVs. They listed the following criteria as important:

- yield, including fodder yield,
- drought resistance,
- eating quality,
- disease resistance,
- ability to cope with weeds,
- need for external inputs,
- storage quality,
- shattering quality and
- duration of crop.

Kodo Millet

Kodo Millet is grown as a cereal in India. The crop has been grown for atleast 3,000 years. Kodo millet is said to be poisonous after rain. This could be due to a fungal infection. The grain is very coarse with a horny seed coat which should be removed before cooking. The crop is highly drought resistant.

Tables 3 and 4 describes the evaluation outcome.

Table 3
Evaluation of Finger Millet (Ragi) *In situ*

Characteristic	Ragi variety Kari kaddi	Hasaru kaddi	Sanna kaddi	HR911 (HYV)
Yield	++	++	+	+++
Drought resistance	+++	+++	+++	-
Fodder	++	+++	+++	+
Good eating quality	++	++	+++	+
External inputs	+	+	+	-
Diseases	-	- -	- -	-
Weeds	-	-	-	- -
Tillers	++	++	+++	+
Storage quality	+	+	+	+
Shattering quality	+	+	++	-
Duration of crop	+	+	+	+
Total	15+, 2-	15+, 2-	18+, 3-	8+, 6-

In the case of ragi, the positive and negative qualities were marked with a "+" and a "-" sign respectively. *Karikaddi ragi* and *Hasarukaddi ragi* had a maximum of 15 "+" and 2 "-", while *Sannakaddi ragi* scored 18 "+" and 3 "-". In contrast, the fairly popular HYV promoted by the agricultural department called HR911 scored only 8 "+" and 6 "-" points.

In the case of paddy, the farmers rated the traditional varieties as against the HYV on a scale of 10. The traditional varieties scored 80 while the HYV scored only 30.

Table 4
Evaluation of paddy *in-situ*
(farmers' assignment of points on a scale of 10)

		Mara Nellu		HYV	
1.	Yield	Moderate yield	8	Higher yield	9
2.	Drought resistance	Good	8	Highly Prone	-
3.	Fodder	3 times more	10	Very little	1
4.	Good eating quality	Excellent food	10	Not good	1
5.	External inputs	Not needed if field is fertile	10	High external input	5
6.	Diseases	Lesser diseases	8	Highly Prone	2
7.	Weeds	Weed problem is less	8	Weed compete	3
8.	Seed storage	Lasts longer	8	Prone to insects	4
9.	Shattering quality	Does not shatter	10	Shatters	5
	Total		80		30

It was interesting to note that the farmers were very aware of the shortcomings of the best of varieties like the *sannakaddi ragi*. This variety is prone to vagaries of the rain and as a result the flowers do not always mature into grain. This phenomenon is referred to as "Enuku Roga" by the farmers.

The farmers also conducted germination tests, agronomic and yield (both grain and straw) evaluations for the ragi and paddy varieties.

Farmers are the back bone of India's seed supply and distribution both in the formal and the informal system.Their continued participation in conservation , selection, characterisation and multiplication and distribution is essential for maintaining a seed supply system that is constantly rejuvenating itself ecologically, culturally, intellectually and economically.

The uncertainty created by environmental changes reflected in processes such as desertification and climate change requires that farm biodiversity is conserved as an insurance to minimise the risks of these environmental changes. Farmers' seed supply is the most effective insurance against environmental risks.

Farmers control over seeds and regeneration of indigenous agricultural diversity is also important in a period of political and economic uncertainty and the possible loss of national sovereignty and security induced by GATT, especially its intellectual property rights regime. Maintenance of farmers' seed supply is the only security.

Farmers' seeds are embodiment of freedom, resilience and stability in an environment characterised by recolonisation, vulnerability and uncertainty.

Foxtail Millet

Foxtail millet is yet another ancient crop, probably domesticated in eastern Asia and known to the Chinese as early as 2700 BC. It was one of the five plants held sacred in China. It is essentially a dry land crop and can be grown throughout the year. The grain is used as food after husking.

APPENDIX

Glossary of Words

Accession - An individual sample of Seeds or Plants entered into a collection in a seed bank.

Back cross : The crossing of a hybrid to one of its parents. Back crossing is generally used to replace unwanted glues from wild or weedy relatives with those from modern varieties.

Clonal Propagation : The Propagation of plants through asexual means, namely without pollination and not by seeds.

Cross Pollination : when one plant is fertilized with pollen from another, it is said to be cross fertilized or open-pollinated.

Ex-Situ : "Out of Site" that is, not in a plants original or natural envirnoment. A seed stored in a seed bank is being stored Ex-situ.

Genetic diversity : The diversity in a group of organisms or individuals.

Hybrid vigour : The intensified expression of desirable genetic traits that makes a hybrid superior to its parents.

Inbreeding : Crossing of closely related individuals.

In-situ : "In-site" that is within a plants original habitat.

Pure line : Crop plants or potential crop plants that have become practically uniform genetically due to extensive inbreeding.

Self Pollination : The Fertilization of a plant by pollen from the same plant.

POLLINATION BEHAVIOUR OF SOME CROPS

	FIELD CROPS	VEGETABLE CROP
a) SELF POLLINATED	Paddy	Cowpea
	Wheat	Clusterbean
	Ragi	Tomato
	Barley	Dolichosbean
	Oats	Frenchbean
	Blackgram	Gardenpea
	Greengram	Lettuce
	Bengalgram	
	Groundnut	
	Soybean	
	Jute	
b) CROSS POLLINATED	Maize	Cabbage
	Bajra	Carrot
	Sunflower	Cucurbits
	Safflower	Onion
	Niger	Radish
	Castor	Amaranthus
	Mesta	
	Sunhemp	
	Mustard	
c) OFTEN-CROSS POLLINATED	Sorghum	Bhindi
	Redgram	Brinjal
	Sesamum	Chilli
	Cotton	Capsicum
	Lucerne	Sweet Pepper
	Berseem	Limabean

NAVDANYA

COLLECTION OF DATA ON CROPS AND RELATED FEATURES

1. Source :
   - i) Name of the farmer..
   - ii) Village.....................................Tq...........................Dist....................
   - iii) Zone...................................

2. Location/Area features :
   - i) Soil type...
   - ii) Climate...
   - iii) Rainfall...
   - iv) Elevation...
   - Land type..............................   Upland/Lowland

3. Crop Features :
   - i) Name of the crop..................................
   - ii) Variety...
   - iii) Cropping season...........................Kharif/Rabi/Summer

4. Farming Features :
   - i) Irrigated/Rainfed
   - ii) Sole crop/Mixed crop
   - iii) Specified cropping pattern

5. Agronomic Features :
   - i) Maturity - Early/Late
   - ii) Cropping period...
   - iii) Height of plant...
   - iv) No. of earheads...
   - v) Leaf features..
     Number/Width/Length etc.
   - vi) Vegetative features if any.............................

6. Yield Features :
   - i) Grain :
   - ii) Straw :
   - iii) Yield at Ideal Condition

7. Grain Features :

   i) Fine/Coarse

   ii) Colour - Outer..............................Inner......................................

   iii) Aroma/Smell.....................................

   iv) Taste..

   v) Cooking characteristics :

   vi) Threshing characteristics :

   vii) Pounding characteristics :

8. Varietal Performance :

   i) Germination

   ii) Seedling Emergence

   iii) Tolerance to drought - Pre germination

   Post emergence : Early days

   Mid days

   Late

   iv) Pest resistance..................................

   v) Disease resistance.............................

9. Storage Features :

   i) Traditional Method

   ii) Max. years of storage

   iii) Storage pest problem

10. Crop Preference : (Why this crop is preferred)

11. Share of this crop in the daily diet :

12. Problems of Processing.

13. Date of Harvest

14. Date of Collection

NATIVE MILLETS

TABLE 3.6.1 **ELEUSINE CORACANA (mandua, ragi)**

1. Curved spikes I
2. Curved spikes II
3. Straight spikes I
4. Straight spikes II
5. Bale patte Ragi
6. Local Beddalu Ragi
7. Dodda Kaddi Ragi
8. Uduru Mallige
9. Pedda Ragulu
10. Kare gidda & Hasaru Ragi
11. Beddalu Ragi
12. Kalyana Ragi
13. Kari Kaddi Ragi
14. Kari Kaddi Ragi
15. Karee Gidda Ragi
16.. Muru Thingala Ragi
17. Gidda Ragulu
18. Kari Kaddi Ragi
19. Beddala Ragi
20. -
21. Hullu pore Ragi
22. Natee Ragi
23. Ananda Ragi
24. Iyyana Ragi
25. kare Murudga
26. Hullu pore Ragi
27. Dodda Ragi

28. Kari Ragi
29. Puttu Ragi (Farm ragi)
30. Poorna
31. Kaddi Ragi
32. Bili gidda Ragi
33. Kari Kaddi Ragi
34. Kaddi Ragi
35. Sanna Kadi/Hasaru Ragi
36. Sanna Kaddi Ragi
37. Kare gidda Ragi
38. Kaddi & Kare gidda Ragi
39. Hasaru kaddi Ragi
40. Kare gidda ragi
41. Kaddi & Kari gidda Ragi
42. Kare gidda ragi
43. Hasaru gidda Ragi
44. Hasaru gidda Ragi
45. Kari gidda Ragi
46. Sanna Kaddi Ragi
47. Sanna Kaddi Ragi
48. Kari gidda Ragi
49. Hasaru Kiddi Ragi
50. Sanna Kaddi Ragi
51. Kari gidda Ragi
52. Hasaru Kadi Ragi
53. Kari kaddi Ragi

54. kari gidda Ragi
55. Dodda Ragi
56. Hainu Ragi
57. Jenugoodu
58. Hullu Ragi
59. Kari gidda Ragi
60. Hullu Ragi
61. Sanna Kaddi Ragi
63. Kare gidda Ragi
64. Dodda Kaddi Ragi
65. Poorna
66. Hasaru kaddi Ragi
67. Sanna Kaddi Ragi
68. Kari gidda Ragi
69. Hasaru kaddi Ragi
70. Kaddi Ragi
72. Sanna Kaddi Ragi
73. Hasaru Kadi Ragi
74. Sanna Kaddi Ragi
75. Sanna Kaddi Ragi
76. Sanna Kaddi Ragi
77. Sanna Kaddi Ragi
78. Sanna Kaddi Ragi
79. Hasaru kaddi Ragi
80. Sanna Kaddi Ragi
81. Kaddi Ragi

GREEN MANURE PROFILE

INDIGOFERA:

Indigofera tinctoria, commonly called indigo, is a shrubby herbaceous plant, 1-2 m tall with erect and copiously branched stems. Leaves are pinnate and 8-15cm long. The small rose, purple or white flowers are borne in spikes or clusters. The seeds, usually 6-12/pod, are much longer than broad. Pods are 1.5-2.5cm long

CROTALARIA:

- There are eight species of Crotalaria which are considered potential green manures.
- Most of these species are short-lived, hollow stemmed, fast-growing and produce dense foliage.
- Species differ in leaf form (simple, trifoliate), flower color, growth rate, plant height and other morphological characteristics.
- Pods contain 5-8 seeds.

SESBANIA SPP:

Sesbania, such as S. rostrata, S. aculeata or S. sesban, are green manure crops which are fast-growing even in flooded conditions. Unlike most other legumes, they fix nitrogen even when the soil contains high amounts of nitrogen (N). A 45-60 day growth of Sesbania can yield the following:

Field Condition	Tons/ha	Kg N/ha
Flooded	25-30	100
Dry	30-35	115

"Sustaining Diversity" deals essentially with the conservation of diversity at the farm forestry level. We in Navdanya have compiled this source book on the basis of our research over 13 years on genetic erosion and actual experience over three years on setting up community seed banks.

The uniqueness of Navdanya is that it builds up on traditional farmers exchange networks while invigorating them with new possibilities and additional knowledge derived from experiences with the formal system. "Sustaining Diversity" is documentation of such an experience.

The Seed and Life

Navdanya, which means nine seeds, is a movement that celebrates and regenerates biodiversity. It is a people's network for the conservation of indigenous genetic resources.

The logo symbolizes the Seed as the source of Life, and the continuity and renewal of Life through cycles of regeneration.

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